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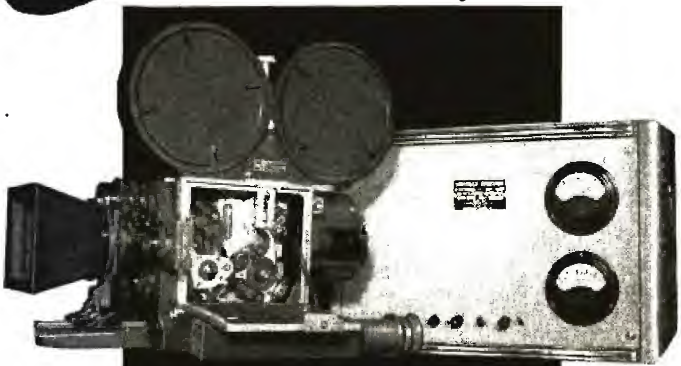

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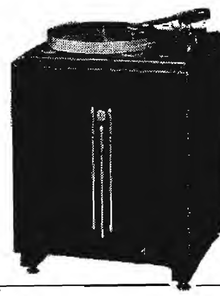

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FEBRUARY, 1948 **VOLUME 28** **NUMBER 2**

COMMUNICATIONS

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COVER ILLUSTRATION

Sergeant Richard Cnnneen, Brookhaven, Long Island, police headquarters dispatcher, at the control desk of the 2-way f-m radio system recently installed. Remote-control console in the background is connected to the relay station in police chief's office on the floor below. (*See page 6, this issue for complete details on the system*).

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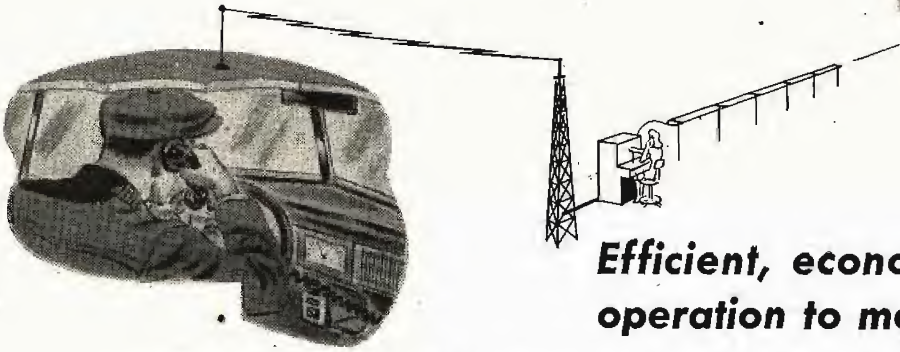

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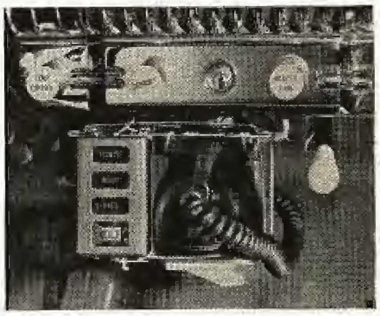

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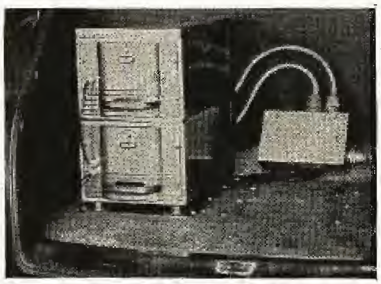
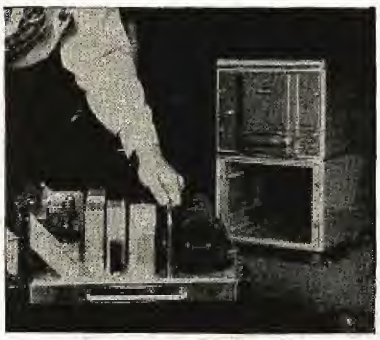


Mobile transmitter and receiver require minimum space in vehicle.



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COMMUNICATIONS

LEWIS WINNER, Editor

FEBRUARY, 1948

Growing Fast

A NOTABLE RECORD of expansion in 2-way mobile services was disclosed at the recent General Mobile Radio Service FCC hearings in Washington. Testimony revealed that close to 13,000 taxicabs had been licensed for 2-way operation and nearly 10,000 were authorized to be equipped. At the close of the year, there were approximately 2,000 applications for 2-way setups. It was also indicated that around 500 taxicab land stations had been licensed, over 400 were under construction, around 150 applications were on file, and 2-way applications for over 1,000 mobile vehicles are being received monthly.

Over 40,000 vehicles have been licensed for truck, bus, cab, Bell telephone and miscellaneous highway or urban radio service. Taxicab use represents approximately 65% of this total or about 25,000 units.

An analysis of the general and miscellaneous common carrier systems revealed that over 2,300 mobile units were equipped for 152 to 162-mc and twenty-five for 30 to 44-mc service, the latter for urban and the former for highway services such as doctor's calling systems, etc., while over 7,500 mobile units were being used on 152 to 162-mc and about 5,000 were being used for 30 to 40-mc operation by the Bell system for common carrier work.

The FCC hearings also revealed that most of the bus radio activity, at the present, is concentrated in Illinois and Michigan, while truck activity is confined to Kentucky, Illinois, Wyoming, Nebraska and Colorado.

Authorized f-m/a-m/tv broadcast stations are also on the increase, with California and Texas leading the parade. At this writing, 228 have applied for broadcast authorizations in California; 129 a-m, 87 f-m and 12 tv. Texas has 223 authorizations; 153 a-m, 66 f-m and 4 tv. Pennsylvania follows with 184 authorizations, of which 98 are for a-m, 80 for f-m and 6 for tv. Next comes New York with 178, which includes 89 a-m, 79 f-m and 10 tv. North Carolina is next with 132, including 86 a-m, 45 f-m and 1 tv. Ohio follows along with 128, which includes 53 a-m, 66 f-m and 9 tv authorizations.

There are 3,119 broadcast authorizations on record, of which 1,969 are for a-m, 1,063 for f-m and 87 for tv, and the list is still growing!

Bandwidths And Channels

THE USE OF the 20 or 40-kc bandwidth in the 30 to 40 or the proposed 44 to 50-mc bands has been quite a debated topic during the past months.

In the main, mobile service users feel that 20-kc channels are not satisfactory.

Reporting on tests made on 20 and 40-kc band widths, at an RTPB meeting, D. E. Noble of Motorola said that a 40-kc receiver using a *triangular* type pass band gave 50 to 100% more range than a 20-kc model. The tests were made in mobile units receiving signals from a ½ to 1-watt fixed transmitter within line of sight. Noble indicated that because of intermodulation effects, it was believed there would be no effective increase in the number of useable channels in a given area by adopting the 20-kc bandwidth.

Budelman of Link Radio stated that laboratory tests indicated that intermodulation and blocking from adjacent channels were the limiting factors for channel utilization in the same area rather than i-f selectivity. It was emphasized that the RMA concept of channel, the useable channel and guard bands, be used instead of the FCC definition which is the spectrum occupied by transmitter radiation.

The 44 to 50-mc and 72 to 76-mc channel problem, recently probed in FCC Washington hearings, was effectively analyzed by D. E. Noble during his testimony. He pointed out that the 72 to 76-mc channel, which the FCC proposes to assign to the aeronautical marker beacon services should be retained for mobile service and that all adjacent channels used by television be assigned to mobile services for land and mobile work. He stated that engineering research will prove that television services will not be disturbed by this arrangement.

Versatility Plus

DESIGNING a high-power transmitter demands the ultimate in resourcefulness, according to Dave Miller, assistant chief engineer of J. H. Bunnell. In designing the 20-kw Bunnell transmitter, Miller reports it was necessary to study, among other things, plumbing, chemistry (for insulation purposes and galvanic and other forms of corrosion), air conditioning (to calculate heat removal by blowers from the transmitter), and central power station techniques for handling the 70 kva of three-phase power to feed the transmitter.. It was also necessary to conduct a bit of research into control systems, become thoroughly familiar with relays, contact problems, armature design, insulation, cabinet ventilation and other factors so that the transmitter would be easy and safe to operate. Quite a job!

Dates To Remember

A HOST OF IMPORTANT conferences and meetings are scheduled for the next few months in the east, middle west and Pacific coast.

The outstanding meeting of the year will be the IRE National Convention at the Hotel Commodore and Grand Central Palace, March 22nd to March 25th. On April 24th, at Cincinnati, there'll be a one-day Spring meeting session of the IRE at the Engineering Society Headquarters Building, during which television will be a featured subject. The annual RMA-IRE Spring Meeting on transmitters again will be held in Syracuse, from April 26th to 28th at the Hotel Syracuse.

The 26th Annual NAB Convention will be held this year in Los Angeles at the Biltmore Hotel, from May 17th to May 21st, with two days devoted to engineering, May 20th and 21st.

The New England IRE Meeting will again be held in Cambridge on May 22nd.

The West Coast group of the IRE will meet in Los Angeles during a 3-day session from September 30th to October 2nd.

Looks as if there'll be plenty to listen to during the next few months.—L. W.

Brookhaven, Long Island, Police 72-76/152-162-mc 2-Way F-M System

Eight Police Cars, Two Detectives' Cars, Jeep and Three Boats Equipped with Two-Way 30-Watt 155.49-mc Units Patrol 443 Square Miles. Relay Stations Operating on 73.22 and 155.49-mc Link Headquarters to Mobile Units and Dispatcher's Offices.

by P. R. KENDALL

Field Engineer
Motorola, Inc.

Two horizontal-polarized dipoles and triple skirt antenna at the central station doghouse on Selden Hill.

Taking a meter reading at the central station installation on Selden Hill.

With the help of a unique two-way f-m communications system fifty-four police officers cover 443 square miles of the Town of Brookhaven, L. I., the largest township in the state of New York. It is unique because it is 100 per cent radio, no land wires being used for remote control.

Terrain Characteristics

Brookhaven boundaries run from the Atlantic Ocean on the south to Long Island Sound on the north, and include more than 30 miles of beach. Between these natural and man-made boundaries lie forty hamlets and villages and hundreds of summer homes ranging from small cottages to sumptuous mansions. Much of the territory is sparsely-settled terrain running from flat beach on the south to hills jutting 350' high in the middle and on the north.

Patrol Equipment

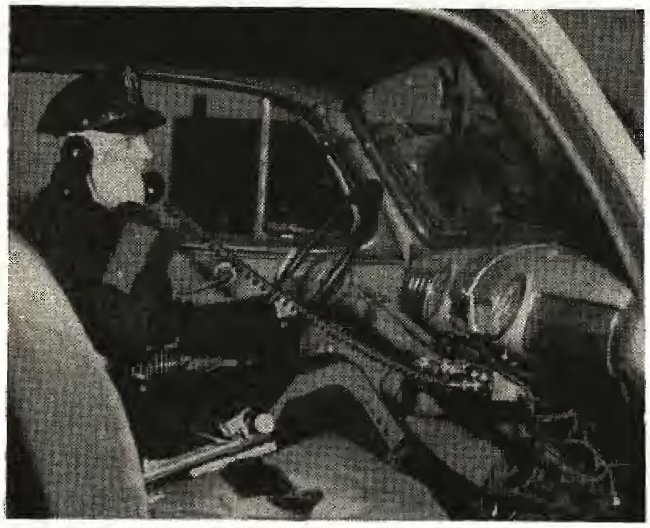
Patroling this heterogeneous territory of water, beach and hills are fourteen radio-equipped vehicles. Eight police cars and two detectives' cars cover the interior, a jeep patrols the beach, and three boats patrol the bay and sound.

The system gives solid uninterrupted coverage over a radius of thirty-five miles and it is possible to cover eighteen to twenty miles between cars.

The Two-Channel System

In studying the Brookhaven communications problem it was found that land wires for remote control could not be used. To cover the broken terrain, obviating numerous dead spots behind hills, the highest point in Brookhaven, Selden Hill, had been selected as the central station site. To reach the hill, six airline miles from headquarters, land wires would have to travel two or

Adjusting horizontally polarized home-made dipole antenna in the attic of Town Hall. Antenna cable leads to the radio relay equipment in the Chief of Police's office which via a short wire is connected to the remote-control console in the dispatcher's office on the ground floor.



Talking to headquarters over the two-way system.

Brookhaven Police radio-equipped car.

more times that distance over sharply rolling, heavily wooded country. In winter these lines would be subjected to storms sometimes approaching hurricane force and be constantly threatened with damage from falling timber. Maintenance under these conditions would be excessively difficult and interruptions would undoubtedly come when the need for communications would be most urgent.

To overcome this problem and insure full coverage, even during static-filled storms, a two-channel radio relay system was developed.

15-Watt Transmitter

Signals from a 15-watt transmitter at Police Headquarters in Patchogue, operating on 73.22 mc, are beamed via a simple dipole directional antenna to a receiver on Selden Hill. A squelch relay on this receiver turns on a 50-watt transmitter operating on 155.49 mc, and radiates to 30-watt mobile units.

74.5-mc Circuit

Signals from the mobile transmitters are picked up on Selden Hill by a 155.49-mc receiver with a squelch relay which activates a transmitter operating on 74.5 mc. This transmitter relays signals to the dispatcher's office.

Antennas Used

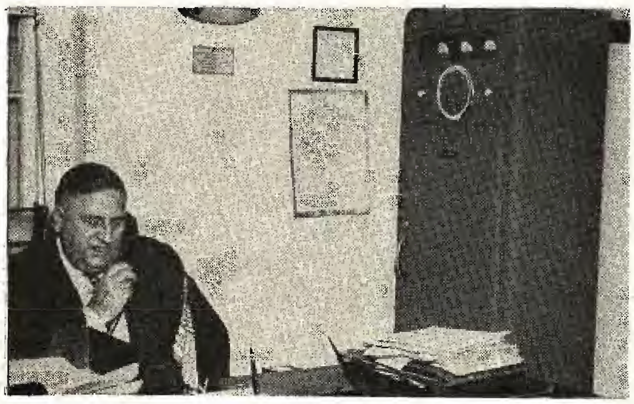
Antennas for the 72-mc relay circuit are simple home-made dipoles, horizontally polarized. The Headquarters antenna is in the attic of Town Hall.

The 160-mc antenna on Selden Hill is a triple-skirt colinear coaxial. Installation of this antenna proved an interesting technical point. Before it was installed, a quickly-prepared simple coaxial dipole fed with RG-8/U copalene cable was put into temporary service. Field tests revealed eighteen miles to be the talk-out limit, and twenty to twenty-two miles the talk-back limit. Had this temporary antenna functioned properly talk-out and talk-back distances would have been equal.

Antenna Tests

Following installation of the present triple-skirt antenna, fed with ⅞" copper dry air filled line, a second set of tests were conducted over the same route and under almost identical conditions. Talk-out and talk-back of equal strengths were conducted over a distance of 27 miles.

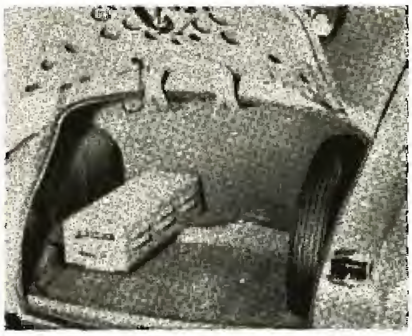
Chief of Police, Edward N. Bridge, at headquarters with the two-way relay equipment setup. System is conneeted by wire to the dispatcher's remote control console on the floor below.



Setup aboard shore patrol boat operating in Long Island Sound, Long Island.

(Left)
Federal transmitter-receiver unit, in taxi trunk compartment.

(Right)
Wilcox Electric transmitter-receiver in trunk compartment of taxicab.



Two-Way Taxicab Radio Systems

by **SAMUEL FREEDMAN**[1]

Engineer, Electronics Division
De Mornay-Budd, Inc.

IN THE INITIAL installment[1] of this series, the economic aspects of 2-way taxicab systems were analyzed. In this presentation, equipment features, current channel problems and system installation problems are discussed.

Technical Cab Radio Advances

Current two-way equipment has been engineered more carefully and expertly than the prewar 30 to 40-mc types.

All operations are f-m and on the 152 to 162-mc band. The reduced wavelength is now sufficiently short to make feasible the *hatpin* type of antenna located on the center of the roof. There, the antenna enjoys an increased horizon and a uniformly maximum efficiency in every direction. Prewar, the antenna was usually mounted on the rear bumper or at the rear of the vehicle slightly above the bumper or fender. It then had a directional characteristic, working as much as 4 to 1 better in the direction where most of the car metal stood between the antenna and the central station. This counterpoise effect is now available in all directions, with the antenna mounted atop the roof approximately at center.

The higher frequency reduces the tendency for sky wave abnormal ranges part of the time which may produce interference and confusion hundreds or thousands of miles away.

The wavelength is becoming sufficiently short so that lumped inductance may be replaced by a resonant line or distributed inductance.

Frequency Multiplication

Equipment utilizes more frequency multiplication to reach the higher frequency with quartz crystals of convenient thickness. The multiplication used varies from 32 to 96 times, as compared to 32 times in most prewar cases on the 30 to 40-mc band. A multiplication of 48 times the crystal frequency is the most popular method employed, and is usually achieved with one quadrupler, one tripler and two doublers.

Power output has been reduced partly by necessity because of the increased frequency multiplications and reduced tube efficiencies at higher frequency, and partly by choice to conserve battery drain. The transmitter power output, quoted by sixteen manufacturers varies from 2½ to 30 watts; see table 1, page 11, and table which appeared in December article.

The number of tubes have been increased, but they are miniature and inexpensive in type. The transmitter may average one more tube, while the receiver may employ three to four more tubes than prewar. The number of tubes employed in the transmitter varies between six and twelve, and in the receiver it varies between eleven and seventeen. The 6AK5 has become the most popular tube used, chiefly for the receiver stages. At least 75% of the manufacturers prefer this tube in the receiver r-f stages, as well as in several other stages. The 2E24, 2E25 or 2E26, 2E30 and 5516 are used most frequently in the driver and final amplifier stages of the transmitter.

Receiver battery consumption varies from 4.6 to 10 amperes. This represents little change from the prewar models.

The transmitter battery consumption varies from 21 to 58 amperes depending on the power rating of the transmitter and the number of frequency multiplication stages. It also depends on the number and type of the special features incorporated in the equipment. Many models use instant-heating tubes in the transmitter. In one model transmitter on standby consumes only .6 ampere for filament heaters.

Several have developed some distinctive type of selective calling or radio privacy system to facilitate dispatching of very large taxicab fleets. Most types work on the principle of keeping all cab loudspeakers dead until the central station actuates the receiver. Some systems further assure communication privacy by patented provisions which keeps all taxicab receivers dead except the one or ones who have their microphone off the

[1]COMMUNICATIONS; December, 1947.

[1]Author of book, *Two-Way Radio*.

Part II. Equipment Features. Channel Problems and Possible Solutions. Installation and Servicing Procedures. Future of Taxicab Radio Systems.

hook. Various modifications of this technique have been developed. Further developments are continuing in this direction by many.

Additional Features

Another model utilizes a synchrocycle circuit which enables receiver to *chase* transmitter as latter drifts in frequency up to a maximum of 15 kc drift. Receiver locks on signal received from transmitters tuning itself automatically.

In another 2-way unit a *lockout* system is used so that only cab with microphone off hook can receive message at discretion of central station dispatcher.

An anti-stickup is a feature of another model wherein any sounds can be picked up by microphone and heard by the entire radio system in the event of foul play.

The price is no more, in some cases even less, than prewar equipment. This is true despite higher labor and material costs existing today, and the fact that the equipment contains more tubes and circuits.

Control cables are simplified or reduced to only one or two between the controls and the equipment.

The operators of radio equipment in the vehicle no longer require a license or permit. Only the central station operator requires a permit or the keeping of a log. The service man still must hold a radiotelephone second or first class license.

All equipment is now much easier to inspect and service. Some units are of drawer type of construction. Most units have convenient provisions for exchange of units.

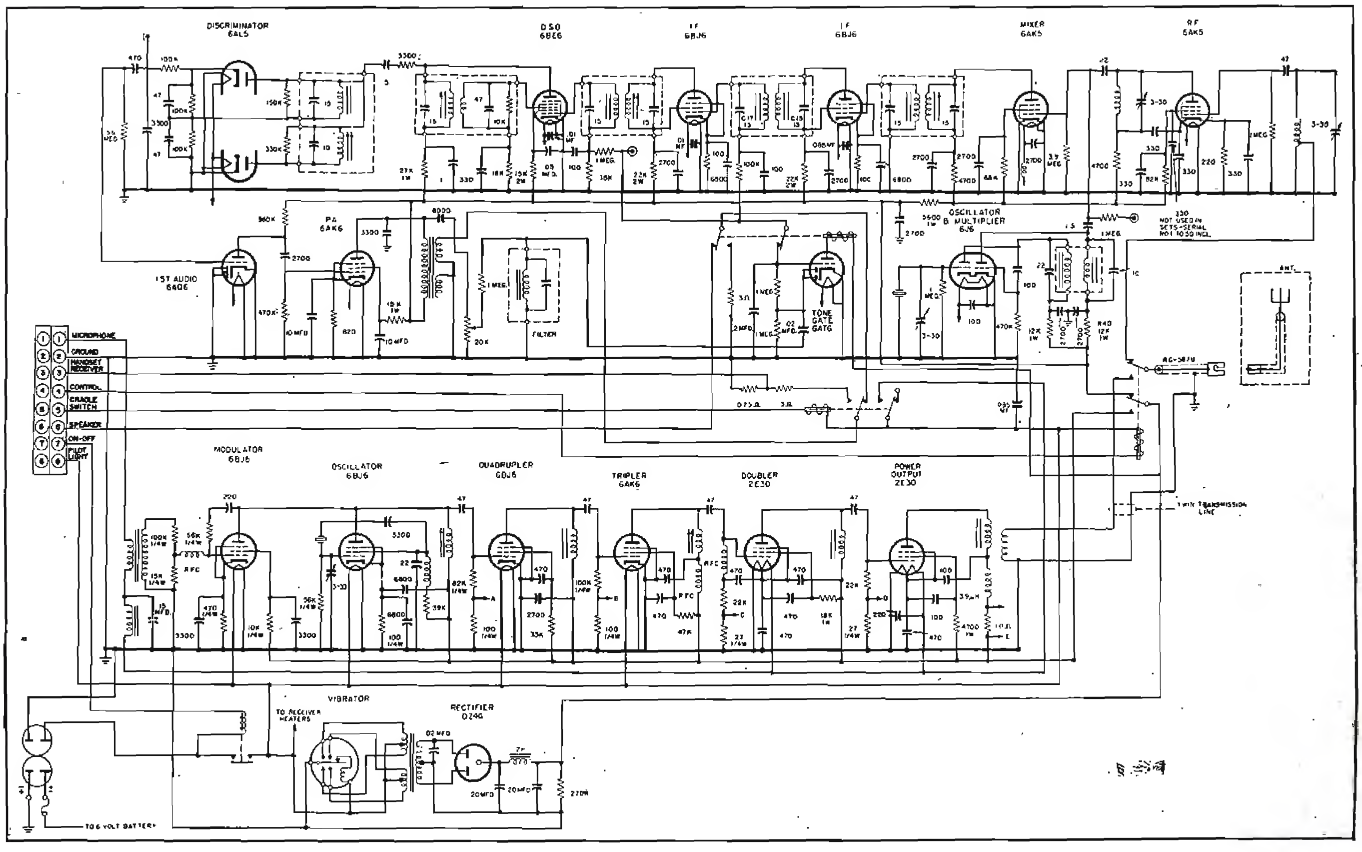
The receivers use more tuned circuits, running as high as twelve, and have better selectivity than the prewar versions. Every receiver offered is capable of a signal rejection of at least 1,000,000 to 1, when the undesired signal is one channel removed.

The discriminator tube has been eliminated in some receivers by the substitution of two 1N34 crystals, reducing battery consumption.

Problems In Taxicab Radio

The most serious cab-radio problem is that of channel space. All taxicab operations in the United States today are being conducted on the same channel. This is only feasible where the cities are small, far apart and where only one taxicab organization exists in one community. This has seldom been the case to date. The situation is naturally aggravated, in large cities and great metropolitan areas surrounding them. It is further aggravated by the fact that taxicabs are very active, with each vehicle able to handle several assignments per hour. The traffic volume per vehicle may be as much as five times greater than that of a police car. Even with careful planning, well disciplined operators, faultless techniques, short messages, minimum call-up or acknowledgment and other considerations, at least six seconds are required to transmit an assignment to a taxicab. It is estimated that the maximum number of taxicabs which can be handled on one channel is between 75 and 100.

The FCC has recognized the problem and its responsibility in this con-



Circuit of the Bendix receiver-transmitter.

nection, and held a hearing recently to review frequency allocations for land transportation services. It is generally anticipated that many additional channels will be made available for cab radio operations.

Channel allocation will have to vary with locality and conditions. It will be necessary to consider the number of taxicabs in a single fleet in a single city or community. There should be one channel minimum per 100 taxicabs.

The number of separate taxicab fleets in one area is another factor. Each fleet should receive different frequencies than that of its competitor or competitors.

Finally there is the problem of the suburban or adjacent cities and communities which might be close enough to interfere with each other or with vehicles in the main metropolis. Thus each community should have separate frequencies.

This would be the optimum allocation of frequencies. It is obvious that the number of channels necessary in the case of our very largest cities would be excessive. A solution may be in providing a limited number of clear taxicab channels on a national basis plus a large number of additional channels on a shared basis. For example, forestry and marine frequencies can in many cases be used because the cities or communities may be remote from areas where such services exist.

Metropolitan Area Problems

New York City still remains an unsolved problem with no two-way taxicab radio provided. There are 14,500 taxicabs in New York operating as many small free-lance fleets, the largest of which is about 700 taxicabs. The drivers work on 42½% commission and are expected to complete 100 paid miles per shift or 200 paid miles for two shifts at the rate of twenty cents per mile. Dead mileage must be met out of the extra toll collected for the first quarter-mile. The rates are twenty cents for the first quarter mile and five cents for each additional quarter mile. To function on that basis, the drivers pay little attention to outlying areas. Instead, they concentrate in the midtown area, terminals or on principal thoroughfares. Cab operators are reluctant to take on the expense and organization of a central station dispatching system which two-way radio would require. A system capable of covering the entire city may

W.E. f-m telephone service system, installed by Bell System.

also be costly. It is here where the Bell system involving radio tolls may be more feasible. With such a system passengers would pay an extra charge for special pickup service similar to that used in a limited way by the Airport Taxi Service in Washington, D. C.

Taxicabs have been able to make satisfactory earnings without two-way radio because of city ordinances which limit the number of taxicabs. A consolidated dispatching and radio system serving all or most of the vehicles from one master point could solve the problem for the populated boroughs, such as Manhattan, Bronx and Brooklyn. Two-way systems could now be used quite effectively in the less-populated areas of New York, such as Staten Island and Queens.

Servicing

Another problem is servicing of equipment in smaller communities where or when a properly qualified and licensed person is not available. Schools have already recognized this need and are offering correspondence and residence courses on receivers and transmitters and first-class radiotelephone procedure. One school[2] is developing men with a 96-week resident school training.

It has been found that one full time service man is required for every 30 to 50 two-way radio stations. The higher figure should be the case with taxicabs who are within reach because they operate within the same city and usually from the same garage. On that basis there already exists a need for nearly 1,000 full-time service men. The number of service men that will eventually be required for installation and service is staggering when it is realized that there are fully 30,000,000 vehicles of all kinds—railroads, trucks, buses, taxicabs, automobiles, secondary vessels and aircraft which can utilize two-way radio.

[2]De Forest Training, Chicago.

Equipment . . . Operating Costs

The total equipment bill for initial installation for the taxicab field past, present and early future is approximately $35,000,000. The annual parts and tube replacement bill, exclusive of service men salaries, is approximately $2,000,000 per year. In the case of systems comprising 100 vehicles or more the overall servicing and maintenance cost for labor and materials will average about $7.50 per month, assuming that parts are purchased at net prices.

Probably 90% of all taxicab business is pick-up type and on 5% of the streets in the modern city or community. It is reasonable to assume that there is enough business existing in the remaining 95% secondary areas to utilize double the number of taxicabs now in service. The development of this additional business is dependent on the full use of two-way radio in conjunction with a central office dispatching system. This dispatching system must operate on the basis of telephone request for taxicab service from the general public.

Emergency Uses of Taxicab Radio

Public agencies such as police, fire, utility, health and public works departments are particularly happy to see two-way radio in taxicabs. Since there are from 5 to 20 times more taxicabs than police radio cars in the average city, the two-way cabs can serve as *roving call boxes* for emergency contacts, without cost to the taxpayers. Cabs are in a position to report fires, accidents, street obstructions and to cooperate with the law.

With the advent of two-way systems, cab operation has become more important than ever, and destined to attract intelligent men to this otherwise ordinary occupation. Two-way communications is now paying off in a record-breaking manner by greatly improving the ratio between operating revenues and operating expenses for the fleet owner, more salary commissions for the drivers and excellent service for the public under all, rather than certain conditions.

Right: Data on seven models of two-way mobile equipment used for taxicab radio service.

Detail	Raytheon (Belmont)	Harvey Radio (541-542)	Link	Comco (Model 210)	Temco [30-FMT/FMR]	Federal (FT-25)	Wilcox [358A]
Number of Tubes (Receiver)	12	14	13	16	13	17	13
Number of Tubes (Transmitter)	9	9	6	8	8	10	8
Number of Tubes (Total)	21	23	19	24	21	27	21
Receiver Tube Lineup	1st R-F, 6AK5 2nd R-F, 6AK5 Converter, 6BE6 Tripler, 6AK5 Oscillator, 6J6 1st I-F, 6BA6 2nd I-F, 6BA6 Limiter, 6AU6 Discriminator, 6AL5 Squelch Amplifier, 6AQ6 1st Audio and Squelch, 6AQ6 Output, 6AK6	1st, R-F, 6AK5 2nd R-F 6AK5 1st Detector, 6AK5 1st I-F, 6AK5 2nd I-F, 6AK5 3rd I-F, 6AK5 4th I-F, 6AK5 Oscillator, 6AK5 Multiplier, 6AK5 Noise Amplifier, 6AK5 1st Audio, 6C4 Squelch, 6AQ6 2nd Audio, 6AQ6 Output, 6AQ5	R-F, 6AK5 1st Mixer, 6AK5 1st I-F, 7AG7 2nd Mixer, 7AG7 Oscillator-Multiplier, 7AG7 Doubler, 7AG7 2nd (5000 Kc) I-F, 7AG7 1st Limiter, 7AG7 2nd Limiter, 7AG7 Discriminator, 7A6 Noise Rectifier, 7A6 Squelch and Audio, 7F7 Audio Output, 7B5	R-F, 6AK5 1st Mixer, 6AK5 2nd Mixer, 6AK5 1st I-F 9001 2nd I-F 9001 3rd I-F 9001 1st Limiter, 9001 2nd Limiter, 9001 Discriminator, 6AQ6 Discriminator, 6AQ6 Audio Amplifier, 6G6 Audio Amplifier, 7AG6 Oscillator—1st Doubler, 9001 2nd Doubler, 9001 3rd Doubler, 9001 4th Doubler, 9001	R-F Amplifier, 6AK5 1st Mixer, 6AK5 Multiplier, 6AG5 Oscillator, 7AG7 30-Mc I-F, 7AG7 2nd Mixer, 7AG7 4.4-Mc I-F, 7AG7 1st Limiter, 7AG7 2nd Limiter, 7AG7 Discriminator, 7A6 Noise Rectifier, 7A6 1st Audio and Squelch, 7F7 Output, 7C5	1st R-F, 6AK5 2nd R-F, 6AK5 Mixer (10-7-mc output), 6AK5 1st local oscillator, 6AK5 Multiplier, 6AK5 1st I-F (10.7 mc), 6AK5 Converter, 6BE6 2nd I-F (1.7 mc), 6AK5 1st Limiter (1.7 mc), 6AK5 2nd Limiter (1.7 mc), 6AK5 Discriminator, 6AL5 Carrier switch tube (squelch), 2D21 Reed Amplifier (in Selecto-Call models), 6AK5 1st A-F, 6AQ6 Output, 6V6GT Rectifier, 6X5GT or 0Z4 [Model 143A]	1st R-F, 6AK5 2nd R-F, 6AK5 1st mixer, 6AK5 Oscillator, 6AK5 1st H-F I-F, 6AG5 2nd H-F I-F, 6AG5 1st L-F I-F, 6AG5 2nd Mixer, 6AG5 1st Limiter, 6AG5 2nd Limiter, 6AG5 Discriminator, 1N35 Noise Rectifier, 1N35 Noise Amplifier, 7C7 Squelch and 1st A-F, 7F7 Output, 6AK6
Transmitter Tube Lineup	Oscillator, 6J6 Modulator {6AK6 6AK6} 1st Tripler, 6BA6 2nd Tripler, 6AK6 1st Doubler, 6AQ5 2nd Doubler {6C4 6C4} Power Amplifier, 832A	Oscillator, 6AQ6 A-F, Amplifier, 6AQ6 Modulator, 6AQ6 Multiplier, 6AK5 Multiplier, 2E30 Multiplier, 2E30 Driver, 5516 P-p Amplifier {5516 5516}	Oscillator-Phase Modulator, 7F7 1st Doubler, 7C7 Quadrupler, 7C7 2nd Doubler, 7C5 3rd Doubler, 2E26 Tripler-Power Amplifier, 829B	Oscillator-Audio Amplifier, 3A5 Modulator {2E25 2E25} Quadrupler, 2E25 Tripler, 2E25 Doubler, 2E25 Driver-Doubler, 2E25 Power Amplifier, 3D23	Oscillator, 7C7 Modulator {7A8 7A8} Quadrupler, 7AG7 Tripler, 7C5 Doubler, 7C5 Doubler, 2E26 Amplifier 829B	Oscillator, 2E30 Modulator 6AK5 Doubler, 2E30 1st Tripler, 2E30 2nd Tripler, 2E30 Amplifier, 2E30 Tripler-Driver, 2E30 Tripler-Driver, 2E30 Output {5516 5516} [Model 282A]	Oscillator, 6AK6 Modulator, 2 6BE6s 1st Tripler, 2E30 2nd Tripler, 2E30 3rd Tripler, 2E30 Doubler, 2E30 Output 832A
Transmitter Power Output	15 watts	30 watts	15 watts	15 watts	30 watts	25 watts	15 watts
Multiplication of Transmitter Crystal Frequency	3 × 3 × 2 × 2 = 36 times	(Optionally) 48 times	2 × 4 × 2 × 2 × 3 = 96 times	4 × 3 × 2 × 2 = 48 times	4 × 3 × 2 × 2 = 48 times	54	54
Receiver Sensitivity For 20-db Signal-to-Noise Ratio	Below 1 microvolt for 50-milliwatt output	½ microvolt	½ microvolt	½ microvolt	1½ microvolts	1 microvolt	Better than 1 microvolt
Receiver Selectivity	60 db down at 120-kc off center frequency	85-db rejection on alternate channels	85 db at alternate channel (120 kc)	40 db at 80 kc; 60 db at 105 kc	6 db down 25 kc; 20 db down 55 kc; and 40 db down at 110 kc	60 db	40 db at 120 kc; 60 db at 200 kc
Receiver Audio Output	1 watt	1 watt	1 watt	700 milliwatts	1½ watts to 6-8-ohm voice coil	1.5 watts; 10% distortion; 2 watts, maximum	1 watt (less than 10% distortion)
Squelch Operating Voltage	1 microvolt	.2 microvolt	.2 microvolt	.5 microvolt	Electron operated relay and biased audio amplifier	Receiver can be turned on in presence of blanketing noise; adjustable by pot. Responses only to signals in proper channel	.3 microvolt

Facsimile Transmitter at the Miami Herald, Florida

Analysis of Equipment, Which Includes Scanner Amplifiers, Limiter Line Amplifiers, Pulse Generator, Recorder Amplifier and Modulator.

by RALPH G. PETERS

Facsimile is rapidly becoming an important factor in special-service broadcasting, particularly among newspapers. An interesting example is the *Miami Herald* who will soon be on the air with a facsimile unit to broadcast stock market news, fashion reports and other business information. Newspapers in Hartford, Conn., Atlanta, Ga., Akron, Ohio, St. Louis, Mo., Washington, D. C., Philadelphia, Pa., New York City and Toronto are also planning facsimile installations.

The equipment[1] at the *Miami Herald* has many interesting features.

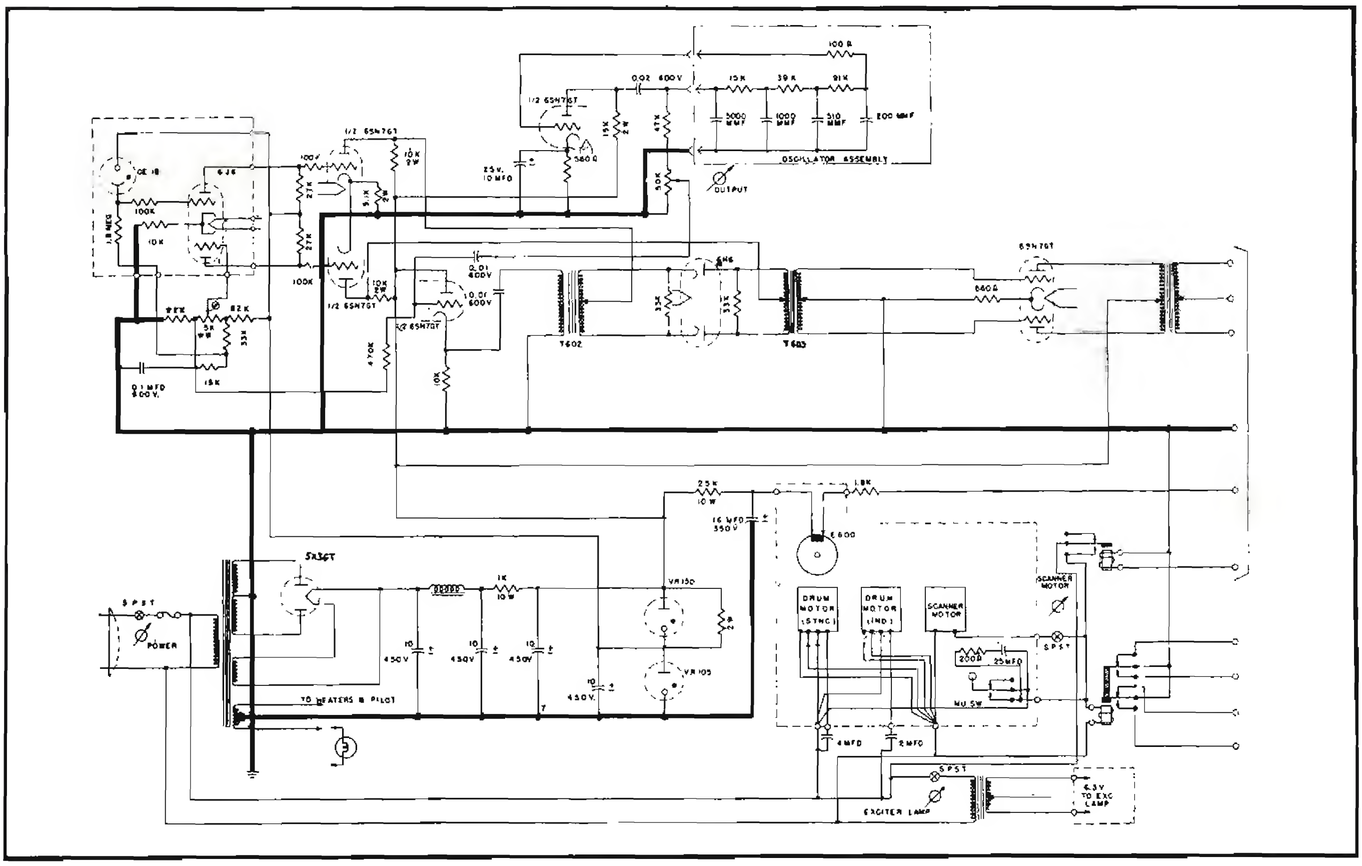
Two scanner, scanner amplifier, and limiter-line amplifier units are used which permits setting up copy on one, while the other is in operation, so that transmission may be continuous.

The scanner has a cylindrical drum about 3″ in diameter and 12″ long. On the right end of the drum shaft is a sleeve which has a worm gear cut in it, which is meshed with a worm on the shaft of a synchronous motor. This motor drives the sleeve at 360 rpm. The sleeve is coupled to the drum shaft through a pawl, which is not engaged when the drum shaft speed is less than the sleeve speed. An induction motor drives the drum through a worm and worm gear, the speed and gearing being such that this motor tends to drive the drum faster than 360 rpm. However, the pawl engages when the drum speed reaches 360 rpm and this speed is then maintained by the synchronous motor.

A lamp, optical system, phototube and amplifier tube are mounted in the carriage. The lamp illuminates a spot on the copy, and the optical system is designed so that the reflected light from a part of this spot, about 1/105″ square, is received by the phototube. The phototube current is thus controlled by the optical density of this 1/105″ square. For each revolution of the drum the carriage advances 1/105″ along the drum, so that the copy is

[1]Manufactured by G.E. for Radio Inventions, Inc.

Figure 2
Schematic of the pulse generator.



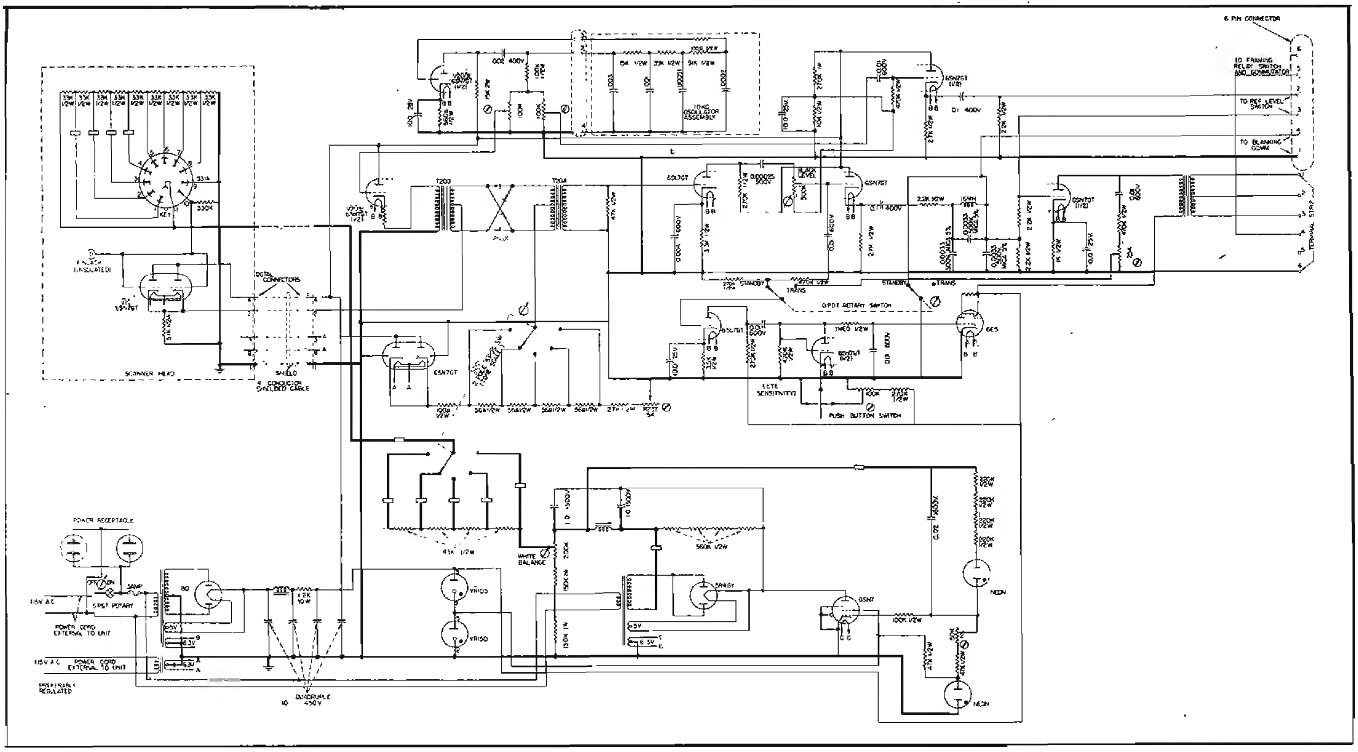


Figure 1
Schematic of the scanner amplifier used in facsimile transmitter.

scanned in a spiral 1/105″ wide and with a 1/105″ pitch.

In this manner the scanner produces electrical signals representative of the optical density, or shade, of the copy as it is scanned. These signals are then fed to the scanner amplifier.

The blanking commutator at the left end of the drum shaft shorts out the signals in the scanner amplifier during ⅛ of each revolution of the drum, while the part of the drum circumference used for securing the copy holder is being scanned. On the driven sleeve there is another commutator which is used in bringing the driven sleeve to the correct angular position or phase with respect to a pulse-generator drum.

The scanner amplifier supplies power to the scanner, and uses the signals from the scanner to modulate a 10-kc subcarrier. The modulated subcarrier is amplified to +10-dbm level into a balanced 600-ohm load.

The signal from the scanner amplifier is further amplified by the limiter-line amplifier.

The amplifier has two inputs. Signals applied to one of these inputs are amplified linearly. Signals applied to the other input are amplified with a limiting characteristic, whereby the output is zero for signals up to a particular value and nearly constant for levels above that value.

Signals from both the linear and limiting amplifiers are applied to a common output.

Both inputs and the output of this amplifier operate with 600-ohm balanced circuits.

Pulse Generator

The equipment also employs a pulse generator which has a special scanning unit shock mounted on the horizontal chassis. In this scanning unit a drum about 4″ in diameter and 1″ long is rotated continuously, a speed of 360 rpm being maintained by a synchronous motor. A lamp, optical system, and phototube are arranged so that the drum circumstance is interposed directly in the light path; one end of the drum is open to allow this. A part of the circumference is cut out and the opening covered with a piece of film on which are printed station call letters or other information to be transmitted as a page-separation signal. The printing is transparent with opaque background.

The light beam is restricted by a slot in the phototube housing parallel to the axis of the drum, with the slot extending from one end of the drum to the other and a little beyond. The light beam is also restricted by a disc with twelve radial slots. The disc is located between the housing and drum with its shaft perpendicular to the drum shaft. The clearances between the drum circumference and the disc, and between the disc and housing are both small. The light path is through the intersection of the slot in the housing and a slot in the disc.

Scanning the drum from end to end is accomplished by rotating the disc through an angle of 30°, which is the spacing between the slots. The disc is rotated at one-half rpm by a synchronous motor. A cam-operated microswitch automatically stops the disc after 30° rotation.

In the position where the disc stops, one of the slots is just past the end of the drum so that light reaches the phototube except when a 15° tab, which projects beyond the end of the drum, interrupts the light once each revolution of the drum. Immediately adjacent to this projection, the drum has a segment of 15° cut out. Therefore light reaches the phototube during this 15° of the drum's rotation regardless of the position of the scanning disc.

The output from the phototube keys a 10-kc subcarrier either on, when the light is interrupted, or off when the light reaches the phototube. As a result, the pulse generator, while the scanning disc is stationary, produces a single pulse for 15° of each drum revolution. This pulse is transmitted simultaneously with a facsimile signal from one of the scanners, the pulse being timed to occur during the interval when the copy-holder clamp of the scanner drum is being scanned and the scanner signal is being shorted by the blanking commutator on the scanner. The pulse generator output is mixed with the signal from one of the scan-

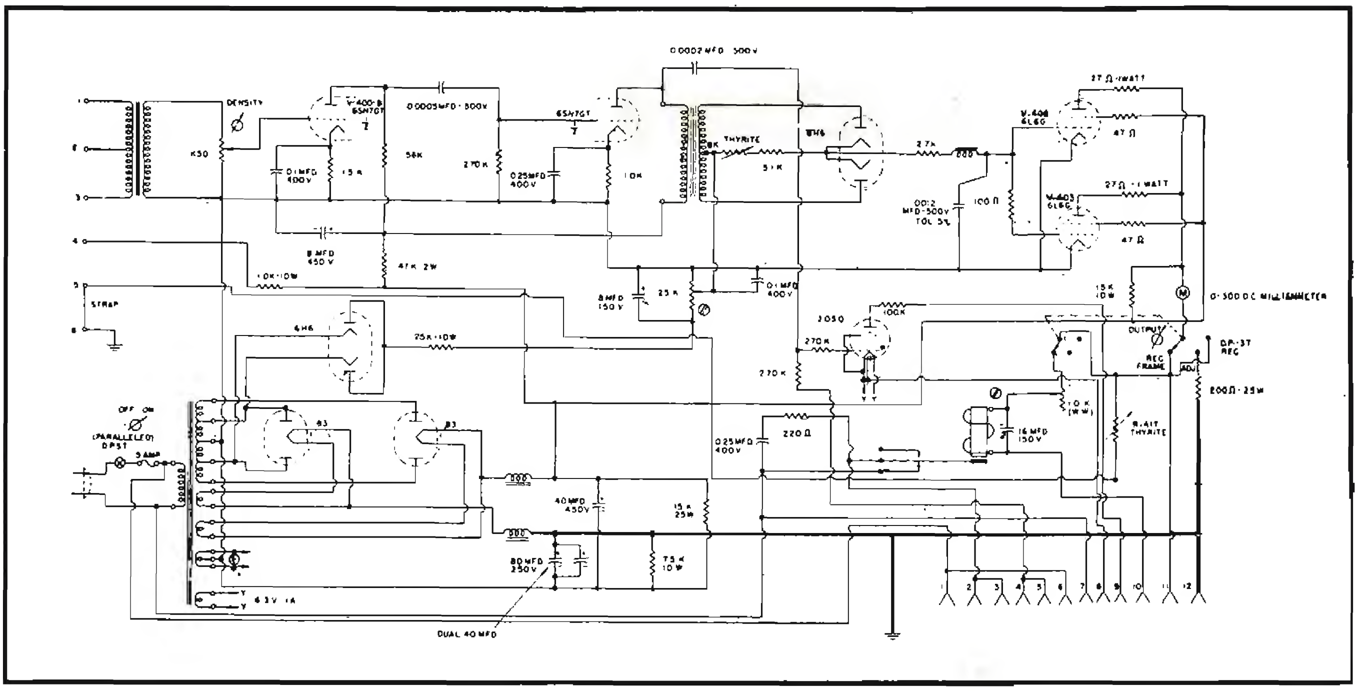


Figure 3
The recorder amplifier.

ning channels in a mixing attenuator, which is mounted inside the right wing of the console. When the disc is rotated to transmit the page-separation signal after concluding a page from one of the scanners, the 10-kc subcarrier is transmitted continuously except for a 15° interruption once each revolution of the drum, and for whatever interruptions result from scanning across the page-separation signal. The subcarrier with 15° interruption serves to phase recorders automatically.

On the drum shaft there is also mounted a commutator which has a 6° conducting segment, having an angular position such that it contacts two brushes at the same time that the drum tab interrupts the light beam to produce the subcarrier pulse. These two brushes are connected so as to furnish a d-c pulse with each revolution of the drum. These pulses serve to phase the scanners, or, in other words, bring the scanner drums into the correct angular position relative to the pulse generator drum.

Recorder Amplifier

A recorder amplifier amplifies the signal, rectifies it, and supplies current corresponding to the signal to mark paper in the recorder. A gain control (*density*) varies the amplification and, thereby, the marking current. This unit also supplies power to the recorder motor, and has a relay to interrupt the power when necessary to phase the recorder.

The recorder has a humidor compartment which holds a roll of chemically-heated recording paper and keeps it moist, and rollers for guiding and feeding the paper. The paper passes over a drum with a raised helix, and the recording current flows from a printer blade above the paper through the paper to the helix. The paper then passes over a heater for drying the paper and intensifying the recording. A synchronous motor drives the helix drum and feedroller by means of a series of gears.

The blackening of the spot where the current flows through the paper is a function of the magnitude of the current. Metal from the printer blade is transferred to the paper by electrolytic action in proportion to the magnitude of the marking current. This metal then combines with the electrolyte to produce a mark of corresponding density. This process gradually consumes the marking edge of the printer blade.

The contrast is accentuated when the paper passes over a heater which dries the paper, the temperature of the heater being controlled by a thermal switch.

The motor has a synchronous speed of 1,800 rpm. The gearing is such that the drum rotates at 360 rpm and the paper advances at a rate of 3.43 inches per minute. Thus the recorder produces 105 lines per inch.

The drum speed is the same as that of the scanner drum, and the paper feed corresponds to the carriage motion on the scanner, with the result that the marking is in exactly the same order as the scanning of the transmitted copy.

Phototube and Modulator Operation

A phototube[2] (Figure 1) receives light reflected from an area of the drum about the 1/105″ square. The phototube is supplied from a regulated supply.

Output from the phototube appears across a 330,000-ohm resistor which is connected between the anode or collector electrode, and ground. In this application no potential is applied to the anode. While the output is much lower than would be obtained with a positive potential on the anode, it is proportional to the logarithm[3] of the illumination on the cathode over a considerable range. It has been found that the output at the upper end of this range is about .6 volt.

The output is applied to the grid of a 6SN7GT which is connected as a cathode follower.

V_{202} (6SN7GT) has its grid grounded, plate connected directly to the same plate supply as V_{101} (6SN7GT) and a 5,000-ohm variable resistance in its cathode. This permits adjusting the voltage from the V_{202} cathode to ground to equal the voltage from the V_{101} cathode to ground for a particular value of phototube output applied to the V_{101} grid.

The cathode of this tube and the cathode of V_{202} are connected to the

[2]Phototube is of the multiplier type in which the current from light sensitive cathode is successively amplified by secondary emission at the dynode electrodes. A balance control varies this voltage and thereby the output from the phototube.

[3]This logarithmic characteristic is very desirable for facsimile transmission.

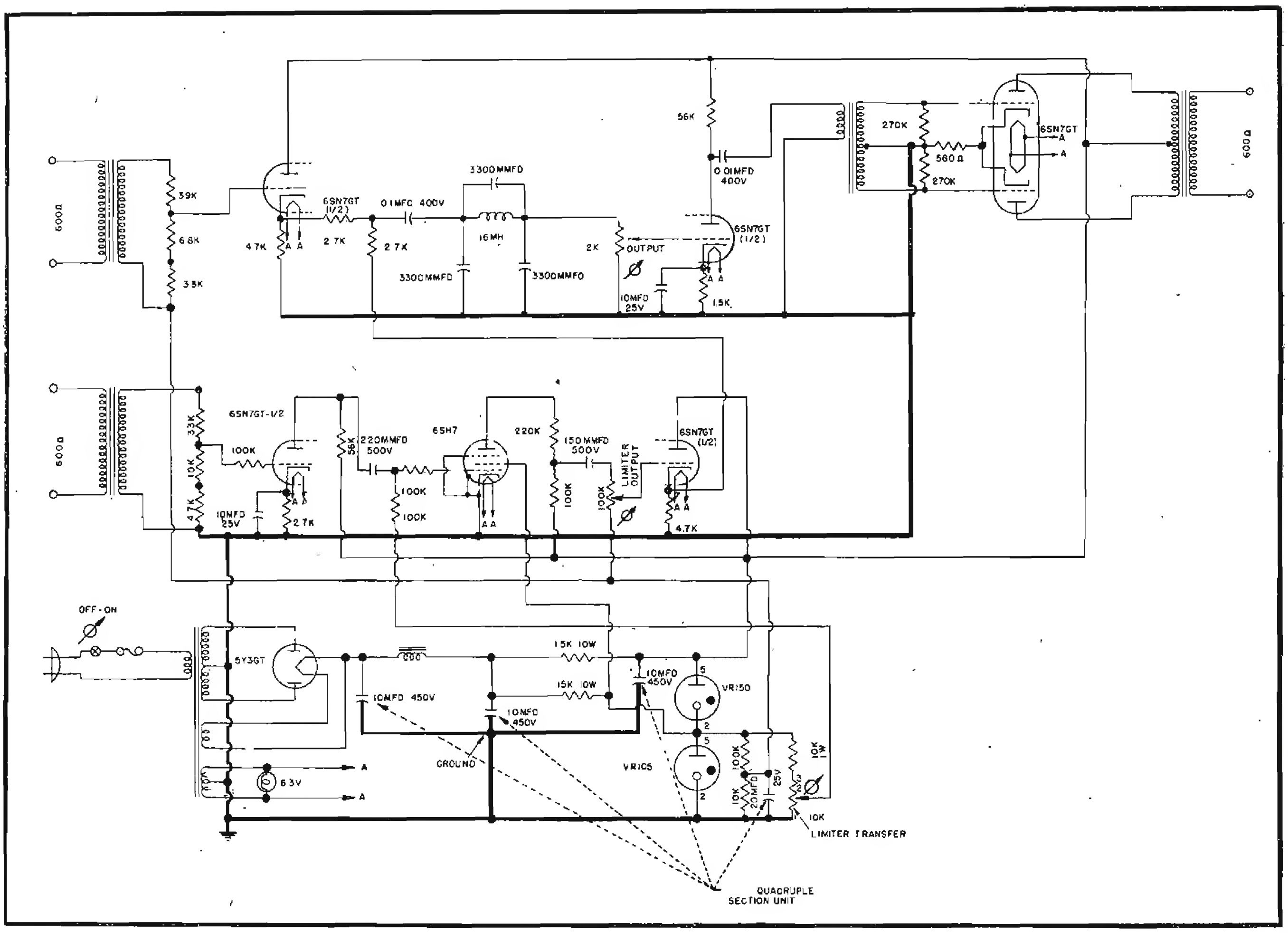


Figure 4
Limiter-line amplifier schematic.

center taps of transformers, T_{203} and T_{204}, respectively, which with CR200 comprise a ring modulator. The 10-kc subcarrier is applied at the primary of T_{203} and the modulated output appears across T_{204}. For equal V_{101} and V_{202} cathode voltages, no voltage is applied to the modulator between the T_{203} and T_{204} center taps, and the output from the modulator is a minimum.

This inversion to produce maximum output from the modulator for minimum phototube output is necessary because maximum signal causes the recorders, which are reproducing the original copy, to mark black.

The 5,000-ohm variable, R_{237}, is adjusted for minimum output with a 2-pole 5-position switch, S_{201}, in a *0* position, and an output of .6 volt from the phototube. Thereafter, when the *white balance* control is adjusted to balance on the whitest area of individual pieces of the copy, the phototube output is automatically set to .6 volt which insures the logarithmic output-illumination characteristics.

Pulse Generator

In this unit (Figure 2) the phototube is resistance coupled to the grid (*5*) of a 6J6 which acts as a d-c amplifier and phase inverter. The voltage on the grid (*6*) is adjusted to set the output of the d-c amplifier with no illumination on the phototube. The output from the 6J6 (plate-to-plate) is amplified further in a 6SN7GT, the output being applied between the center taps of the transformers.

Diodes, 6H6, are connected between, T_{602} and T_{603}, so that when the plate of one section of the 6SN7GT is positive with respect to the other, the diodes are conducting. This completes the circuit between the transformers, T_{602} and T_{603}, so that 10 kc is transmitted through these transformers to a 6SN7GT amplifier. Conversely, when the plate of the 6SN7GT is positive with respect to the other section, the diodes are non-conducting and the 10 kc is blocked from the amplifier.

Recorder Amplifier and Recorder

The plate supply is operated with negative off ground so that the recorder printer blade, which is in a plate circuit, can be grounded. Otherwise, insulation of the recording paper as well as the printer blade would be necessary.

A *thyrite* resistor (Figure 3), R_{417}, is shunted between the helix and printer blade. This has the property of having a high resistance at low voltages which decreases as the voltage is raised. In this application it serves to complete the plate circuit of V_{402} and V_{403}, if the circuit between the helix and printer blade is open, so that screen current does not become excessive and to prevent a high voltage across the paper which could otherwise occur if the paper became dry. This might cause sparking through the paper. The resistance is high enough so that the thyrite has no effect for normal recording.

Phasing of Scanner

It is necessary to have a definite angular relation between the drums on the pulse generator and the scanners. Both pulse generator and scanner drums are driven at 360 rpm by synchronous motors supplied by a common source of 60-cycle power. The motors may lock into synchronism with any one of twenty possible angular relations between the drums, differ-

(*Continued on page 33*)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Haraden Pratt, who is now second vice president of the VWOA.

THE COMMUNICATIONS INDUSTRY is well represented on the 1948 VWOA officers' roster and board of directors.

Our prexy, William J. McGonigle is with the New York Telephone Company. First vice president, A. J. Costigan is vice president of Radiomarine Corp. of America and second vice president Haraden Pratt is vice president and chief engineer of Mackay Radio and Telegraph Co. Genial secretary W. C. Simon is general manager of the Tropical Radio Service Corp., a subsidiary of United Fruit Company. Assistant secretary H. T. Hayden, Jr., is with Ward Leonard Electric. C. D. Guthrie, VWOA treasurer, was formerly with the U. S. Maritime Commission and is now retired.

On the board of directors are George H. Clark of RCA; Jack Poppele, chief engineer and vice president of WOR and TBA president; Fred Muller, captain U. S. N. R., in addition to Bill Simon, A. J. Costigan, C. D. Guthrie, Bill McGonigle and Haraden Pratt.

Annual VWOA Meeting

THERE WAS QUITE a turnout at the annual VWOA meeting at the Fireplace Inn in New York City. Among those present were G. H. Clark, Lucien E. Bonduaux, V. P. Villandre, W. Jablon, C. D. Guthrie and son, Rod Chipp, H. T. Hayden, Jr., Earl Nelson, R. J. Iversen, Roscoe Kent, Frank Melville, George T. Duvall H. L. Cornell, Dave Carruthers, R. D. Davis, Ben Beckerman, Charles Cooke, as well as, of course, Bill McGonigle and Bill Simon.

George Duvall reported that he is as busy as, with television work these days, but he doesn't mind it. . . . Frank Melville is also quite active with his school where television, f-m and commercial radio courses are given. . . . R. J. Iversen is still clearing the air lanes for the New York *Times*. . . . Walt Jablon has gone over to Espey where he'll be vice president in charge of sales. Walt was with Hammarlund for 18 years. . . . Florida kept C. Seid away from the meeting. Hope you're having a good time CS. . . . F. McDermott couldn't make it because of quite an important event, visiting with his son and family for the first time in seven years. . . . Jack O'Keefe wanted to come but his activities at French Cables kept him away. . . . An evening watch kept M. G. Carlir away from the annual meeting. . . . Orth of CBS was on night duty and couldn't come either. . . . W. J. Barkley, executive vice president of Collins Radio, was out on the west coast and couldn't attend but wrote in to say that he'll be at the dinner cruise on February 28th. . . . Ludwig Arnson, president of Radio Reception was called out of town and sent his regrets on the night of the annual meeting. . . . Jack Poppele had made arrangements to come to the meeting but was called away at the last moment. . . . Ed. G. Raser had hoped to drop in at the meeting but just couldn't make it. He reports that Bud Waite, Jr., recently returned from his second trip to Little America, is now in Churchill, Canada on a special mission for the Signal Corps. Bud was at Bikini during the atom bomb test in charge of communications detail. . . . Francis J. Herrmann reported that he couldn't attend the annual meeting but he'll be at the annual dinner cruise. . . . Bill Stedman had a night shift program to take care of on the eve of the meeting.

VWOA veteran George E. Sterling, who has been appointed a FCC commissioner. GES was formerly FCC chief engineer.

William C. Simon, who was reelected secretary of the VWOA.

The Annual Dinner Cruise

COMPLETE DETAILS on the Annual Dinner Cruise, which will be held at the Hotel Astor, on February 28th, are now in the mails. Members are urged to mail in their reservations for tables promptly. There'll be quite a crowded program of activities and many surprises. Hope we'll be seeing you!

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- **Interchangeable Units**—transmitter and receiver sections slide out for fast servicing
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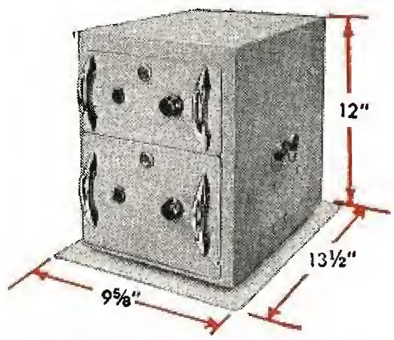

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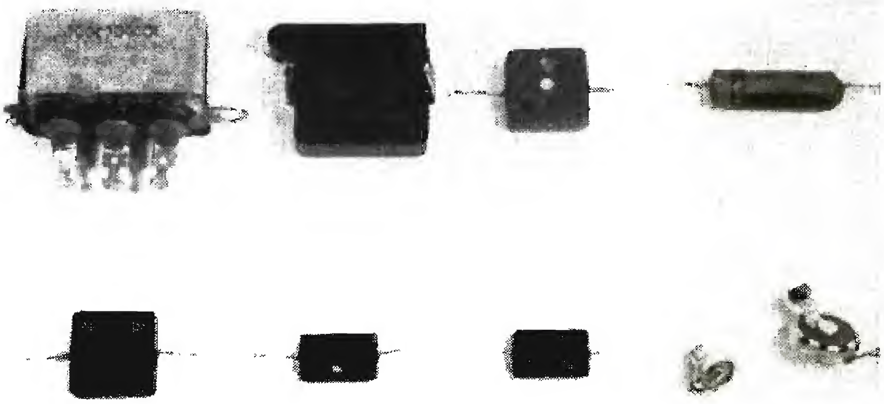


Figure 2
Nine types of bypass capacitors that were checked by Price.

Effectiveness of Bypass Capacitors at V-H-F

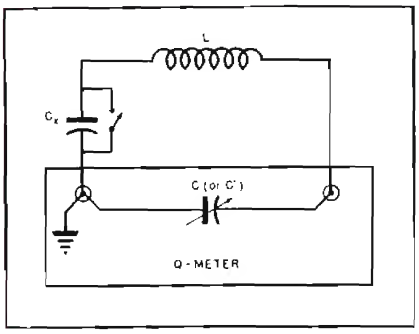
IN A VACUUM-TUBE AMPLIFIER STAGE operating at v-h-f, occasionally there is an unexplainable loss of gain and a large *minimum* bandwidth. This can be due to improper bypassing of the plate, screen or cathode returns in the amplifier stage. The amount of capacity used to bypass these returns is seemingly adequate from the value of the capacitance inscribed on the case. However, at very high frequencies, certain capacitors have resistive and reactive components that make the effective impedance quite large and, in some cases, the equivalent circuit of this *capacity* is an inductance. Manufacturers realize this and strive in capacitor development to make their units small and use a dielectric of good quality, thus minimizing the change in capacity with frequency. Even with excellent design, however, there is a limit to the frequency at which a bypass capacitor can be effectively used. In some cases this frequency limit is lower than the operating frequency of the amplifier stage in which it is used.

This design pit-fall can be overcome with the aid of a high-frequency Q-meter, with which it is possible to determine, in advance, the effectiveness of a bypass capacitor. In this method, the capacitor under test is connected in series with the *low* side of an inductance, the combination connected to the inductance terminals of the Q-meter, and then the combination is tuned to resonance with the meter's capacitor. From Figure 1, it will be noted that if the bypass is an effective one, the Q-reading on the meter, and the variation in capacity of the instrument's capacitor will not change from that of the inductance alone applied to the inductance terminals of the Q-meter. However, if this is not the case, the capacitor under test may have a resistive component, as well as an appreciable reactive component that changes the Q-reading and the capacity required to tune the combination to the desired frequency.

*Care must be exercised in the insertion of the capacitor in series with the inductance so as not to introduce *strays*. The most satisfactory arrangement is to build a *jig*, using metal strips and polystyrene. The capacitor under test can be mounted by soldering it to lugs, and *reference* values for Q and capacity can be made by simply shorting the terminals where the capacitor is attached.

**The amount of inductance to be used at the test frequency is determined by the capacity value of the bypass. If the value is, say, 500 mmfd, then the inductance should be such that it can be tuned to resonance with a capacity of a value no larger than 1/20 of the bypass capacity or 25 mmfd. This will allow certain assumptions that will simplify a quantitative determination of the test capacitor's components.

Figure 1
Schematic circuit of the test procedure used by Price to evaluate bypass-capacitor effectiveness at v-h-f.



Since the capacitor under test can be inserted and shorted out in a manner that minimizes strays,* one can qualitatively check the capacitor in the following way:

(*1*) With the test capacitor shorted out, the amount of capacity needed to tune the inductance** to resonance is recorded. Next, the value of the Q-reading on the meter is recorded.

(*2*) The short is removed from the test capacitor and the new value of capacity needed to tune the inductance to resonance as well as the new value of Q is recorded.

In determining the effectiveness of a bypass capacitor, qualitatively, two points must be considered:

(*1*) If the amount of capacity required to tune the combination of coil and test capacity to resonance was *more* than the amount of capacity needed to tune the coil alone to resonance (at the same frequency, of course), then the test capacitor is acting as capacitance. (*2*) If, on the other hand, the capacity needed to tune the combination was *less* than the amount of capacity needed to tune the coil alone, then the test capacitor is acting as an inductance at the test frequency.

Data on just how much capacitance or inductance the test capacitor represents appears in the following quantitative discussion.

The fact that the capacitor is behaving as such is not sufficient to permit one to say it is satisfactory at the test frequency. The matter of the

Qualitative and Quantitative Tests at 30 and 100-Mc on Paper, Tubular, Postage Stamp, Mica Molded, Mica Silvered and Button Mica Types Reveal Capacitive and Inductive Factors to Be Considered in Selection of Capacitors for V-H-F. H-F Q Meter and Simple Set of Equations Used in Checking Method.

by JOHN F. PRICE

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Washington, D. C.

resistive component has to be determined.

The resistive component can be found from the loss in Q when the test capacitor is inserted. If the circuit Q changes appreciably (say more than 20%), then the resistive component is too high for effective bypassing*** at the test frequency.

Quantitative Check

In conducting a quantitative check, let us assume the test capacitor had been subjected to a qualitative test and the values of tuning capacity and indicated Q recorded. Then, let

Q = the Q of circuit of the coil alone applied to the inductance terminals of the Q-meter.
Q' = the Q of the series combination of coil and test capacitor.
R = the resistance of the circuit of the coil alone (at the test frequency).
R' = the resistance of the test capacitor alone (at the test frequency.)
C = The amount of capacity needed to tune the coil to resonance.
C' = the amount of capacity needed to tune the series combination of the coil and test capacitor to resonance.
$W = 6.28 \times$ the test frequency.
L = the inductance of the coil.

Since

$$Q = \frac{WL}{R} \text{ and } WL = \frac{1}{WC}$$

at resonance, then

$$Q = \frac{WL}{R} = \frac{1}{WCR} \quad \text{or} \quad R = \frac{1}{WCQ} \qquad (1)$$

R can then be found, because W, C and Q can be determined from the dials on the Q-meter if the distributed capacity can be neglected. It is not R we are after but R', which can be found in the following manner:

If

$$Q = \frac{1}{WRC}$$

after inserting the test capacitor

$$Q' = \frac{1}{W\,(R + R')\,C} \quad \text{(If } C \text{ does not change appreciably)} \qquad (2)$$

C will not change much if the coil is large enough to require a value of C to tune it that is considerably smaller than the capacity of the test capacitor. Then, solving (1) and (2) for R', thus eliminating R, we get

$$R' = \frac{1}{WC}\left(\frac{1}{Q'} - \frac{1}{Q}\right) \qquad (3)$$

The actual change in C is small compared to the term in parenthesis and hence equation (3) holds.

The magnitude and direction of the change in C is important, however, as the effective capacitance (or inductance) of the test capacitor can be found from these values.

If the capacitor is behaving as an inductance, C will be *greater* than C', and, since the test frequency is held constant,

$$W^2LC = 1 = W^2\,(L + L')\,C',$$

where L' is the *inductance* of the capacitor. And, since

$$L = \frac{1}{W^2C}$$

then

$$L' = \frac{1}{W^2}\left(\frac{1}{C'} - \frac{1}{C}\right) \qquad (4)$$

When C is *less* than C' then the test capacitor is behaving as a capacitance

(*Continued on page 32*)

***It will be recalled that circuit Q should be maximized in a v-h-f amplifier, as high circuit Q yields high gain and greater signal-to-noise discrimination.

Capacitor	Rated Capacity	Cap. or Ind. at 30mc	Cap. or Ind. at 100 mc	Resistance 30 mc	Resistance 100 mc	30-mc Data Q	30-mc Data Q'	30-mc Data C mmfd	30-mc Data C' mmfd	100-mc Data Q	100-mc Data Q'	100-mc Data C mmfd	100-mc Data C' mmfd
Paper	.1 mfd	.04 µh	.01 µh	.295 ohm	.262 ohm	206	153	31.2	29.9	240	134	20.3	18.3
Mica	.001 mfd	.0013 mfd	......	.000 ohm	....	206	206	31.2	32.0	*Inductive**			
Mica Postage Stamp	.01 mfd	.004 µh	.002 µh	.020 ohm	.011 ohm	209	204	31.2	31.1	236	228	20.3	19.9
Paper Tubular	.001 mfd	.0016 mfd	......	.262 ohm	....	204	155	31.2	31.8	*Inductive and Resistive*			
Mica Silvered	.003 mfd	.001 mfd	.002 µh	.000 ohm	.012 ohm	206	206	31.2	31.3	241	232	20.3	20.0
Mica Molded	0001 mfd	100 mmfd	93 mmfd	.316 ohm***	.094 ohm	206	140	31.2	46.9	242	182	20.3	26.0
Mica Molded	.0005 mfd	495 mmfd	......	.007 ohm	....	207	190	31.2	33.2	*Inductive and Resistive*			
Small Button Mica (Silver)	.0005 mfd	518 mmfd	610 mmfd	.028 ohm	.003 ohm	207	200	31.2	33.2	232	230	20.3	21.0
Large Button Mica (Silver)	.002 mfd	**	.002 mfd	.000 ohm	.001 ohm	207	207	31.2	31.2	235	234	20.3	20.5

*Data taken on only one-half on the inductive types.
**Indicates capacity is greated than .002, but error in reading the dial was as great as $C' - C$.
***This value obtained by using a value $\frac{C' - C}{2}$ for C in calculating for R'.

Tabulated results of tests made on nine sample capacitors

Measuring F-M Antenna Patterns With Miniature Antennas

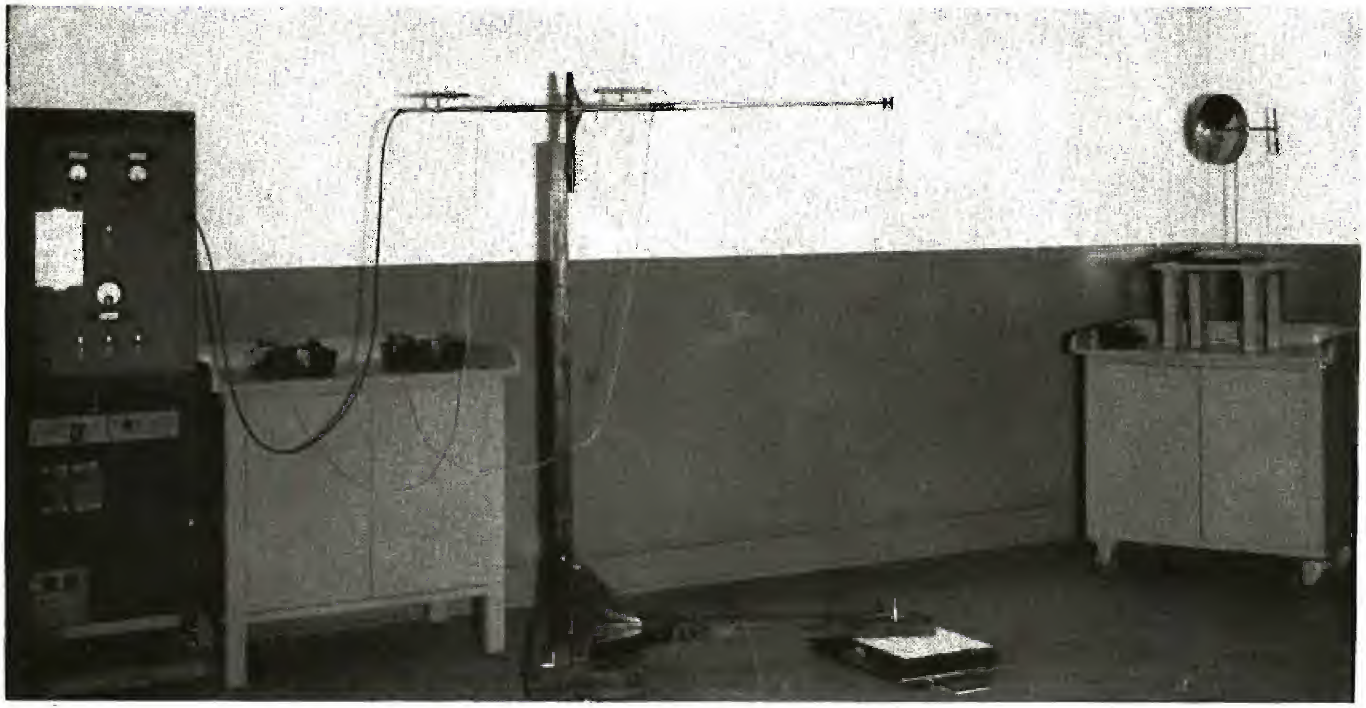

Figure 1
Complete setup of equipment used for measuring vertical radiation pattern of microwave antennas

Simple Setup Used to Measure Vertical Radiation Patterns of V-H-F Antennas, Antennas Being Scaled Down to Microwave Dimensions for Convenience in Pattern Measurements.

by M. A. HONNELL and J. D. ALBRIGHT

Professor of Electrical Engineering   Graduate Student

Georgia School of Technology

In the development of high-gain antennas of the types employed in f-m broadcasting, it is important to measure the horizontal and the vertical radiation patterns. A multi-element antenna designed for this purpose is quite heavy and unwieldy, and is, therefore, inconvenient to rotate about its horizontal or its vertical axis.

A reasonable solution of this problem is to scale the antenna down to operate at microwave frequencies, and to measure the vertical and horizontal radiation patterns by placing the field-strength measuring set in a fixed position, while the transmitting antenna is rotated in turn about its vertical and horizontal axes.[1]

It is a comparatively simple matter to obtain the horizontal radiation pattern of a microwave antenna, since it may be conveniently rotated about its vertical axis. It is inherently more difficult to measure the vertical radiation pattern of an antenna.

The problem was solved with a comparatively simple apparatus* which provided measurements of vertical radiation patterns of antennas operating at a wavelength of 10 centimeters.

*Apparatus was built in connection with a research project in which it was desired to determine the vertical radiation patterns of biconical antennas and other antennas used in the 88 to 108-mc f-m band.

Description Of Equipment

The construction of the antenna-pattern measuring device is shown in Figure 1. It consists of a well-braced L-shaped wooden frame pivoted at one end, with the opposite end mounted on casters in order that the frame may be rotated freely about the pivot. A large protractor mounted about the pivot indicates polar angles.

The microwave antennas are mounted directly over the pivot at the end of the transmission line which is fastened horizontally on a metal flange at the top of the wooden upright. The outer conductor of this line is standard ⅜" copper tubing, while the inner conductor is ⅛" rod. The line has a nominal characteristic impedance of 55 ohms, which is close to the value of

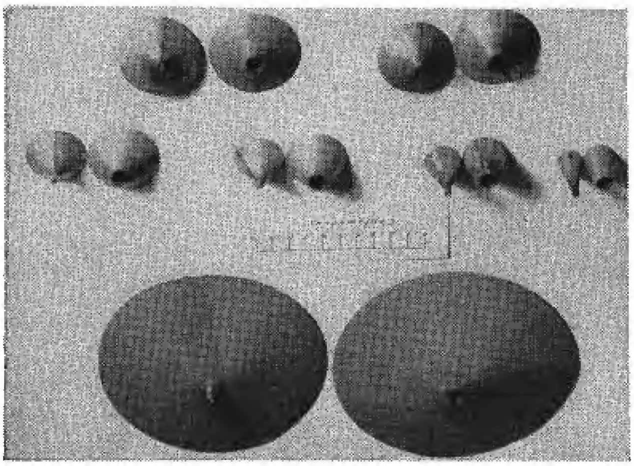

Figure 2
Typical biconical antennas tested.

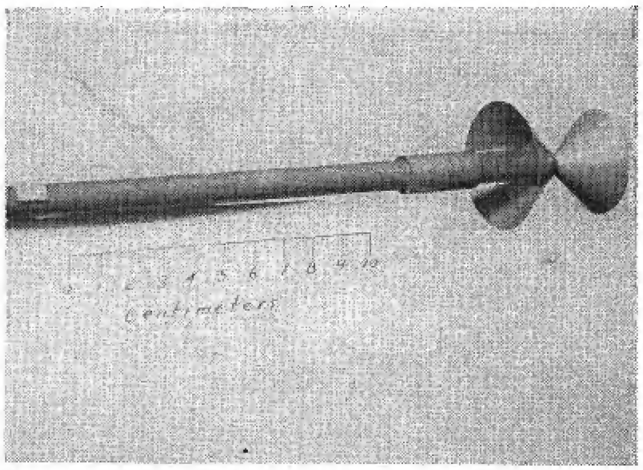

Figure 3
Biconical antenna, having a 30° angle, with a decoupling sleeve in position.

51.5 ohms recommended for f-m and television uses.

A slotted-line section is used to measure standing-wave ratios for the purpose of calculating the input impedance of the antennas. To facilitate probing, the slotted line is made from a section of 55-ohm, ⅞″ coaxial transmission line connected to the ⅜″ line by means of tapered line sections three wavelengths long, having tapered inner and outer conductors.

The input voltage to the line and standing waves in the slotted section are measured with stub-tuned crystal detectors and associated microammeters. The line assembly is connected to a 10-centimeter klystron oscillitator through a flexible coaxial cable. It is important that the klystron power supply be well regulated to keep the input to the antenna constant.

The radiated wave is received on a simple field-strength meter consisting of an antenna, a crystal detector, and a recording meter. The receiving antenna, Figure 1, consists of a half-wave dipole and parasitic reflector at the focus of a small parabola. The dimensions of the receiving antenna should be small if sharp angular definition is desired.

The crystal detectors used in conjunction with the slotted line and with

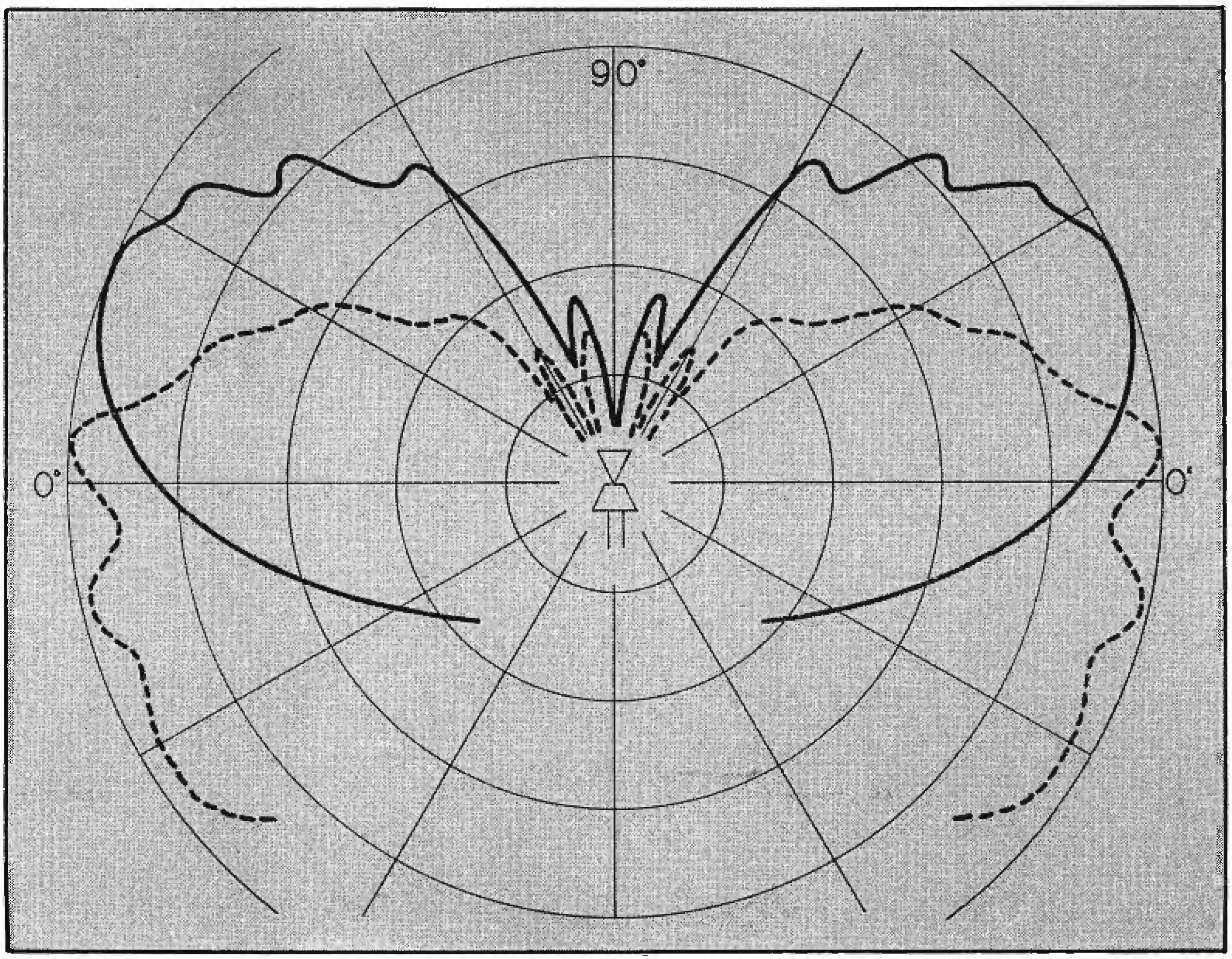

Figure 4
Measured vertical radiation patterns of biconical antenna having a 10° flare angle. The broken-line pattern was obtained when a quarter-wave decoupling sleeve was added.

antenna by using it as a receiving antenna.[4] In this case, the frame supporting the antenna may be mechanically connected to a polar-type graphic recording meter to plot directly the directional pattern of the antenna.

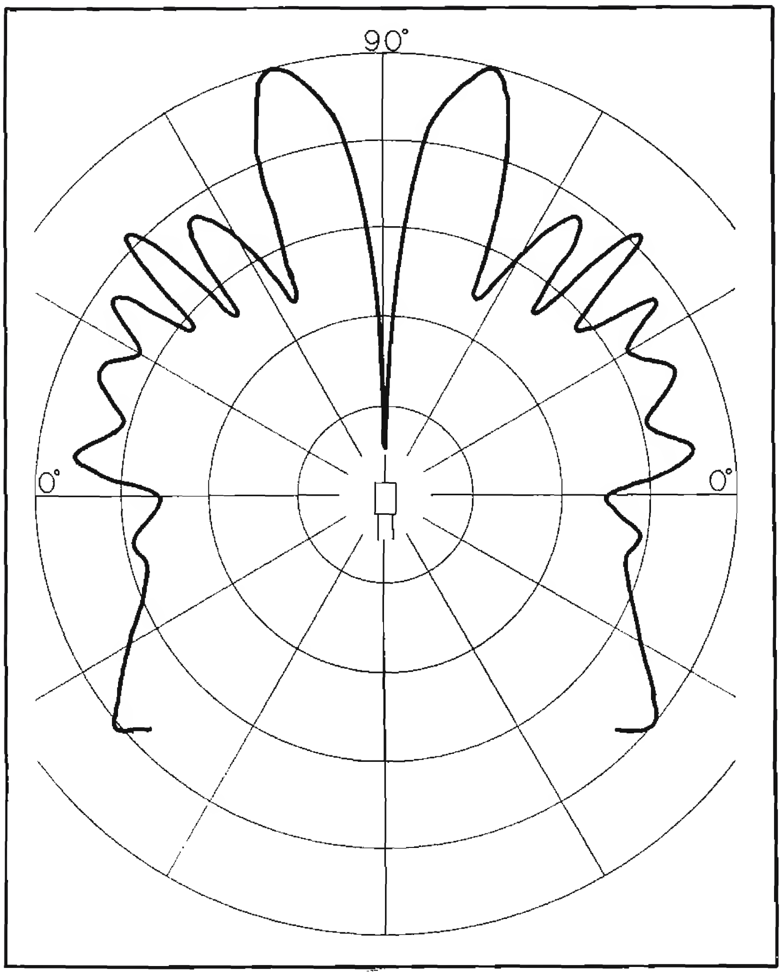

Figure 5
The measured vertical radiation pattern of a coaxial antenna.

the receiving antenna must be calibrated since they have non-linear response characteristics.[2] Greater overall sensitivity may be obtained by modulating the klystron with a square wave. The output of the crystal detector is then amplified and recorded on a vacuum-tube voltmeter or copper-oxide rectifier meter.

Figure 2 illustrates some of the typical biconical antennas tested. A close-up of one of the antennas mounted in position is shown in Figure 3. A quarter-wave decoupling sleeve is seen on the line next to the antenna.

Measurement Technique

Antenna pattern measurements are preferably made in a large open area. However, satisfactory measurements may be made in a large room reasonably free from reflecting obstructions.

It is important to insure that the input power to the antenna system be kept constant. This is conveniently achieved by use of the monitoring crystal detector at the input to the line, as shown in Figure 1.

The receiving antenna is placed at a point remote from the transmitting antenna, and the relative field strength is recorded as the transmitting antenna assembly is rotated about the pivot. Readings are customarily obtained for angular increments of 5°. The presence of minor lobes and of nulls is determined with greater accuracy by using a graphic recording meter in conjunction with the field-strength equipment.

A standard technique is used to measure the input impedance of the antennas.[3] The magnitude and nature of the antenna impedance is calculated from the measured standing-wave ratios and node positions in the slotted line. The slotted line section is not a necessary part of the system, if impedance values are not required.

In many cases it is more convenient to obtain the radiation pattern of an

[5] Data on measuring equipment, described in this paper, were taken in part from a master's thesis research project pursued by Mr. Albright under the direction of Professor Honnell.

Typical Results

The vertical radiation pattern of a biconical antenna with a flare angle of 10° is shown in Figure 4. This pattern was obtained in a 20' by 30' room with a separation of approximately 20 wavelengths between the transmitting and receiving antennas. The effect of the decoupling sleeve on the radiation pattern is clearly shown in the figure.

Figure 5 shows the measured vertical radiation pattern of a coaxial antenna which was expected to have a pattern closely resembling the theoretical pattern of a vertical dipole. The advantage of being able to measure the vertical pattern of an antenna is immediately apparent. The distortion of this pattern is due in part to spurious currents flowing on the outer surface of the coaxial line.

In conclusion, it was found that a considerable amount of time is saved in the initial testing of antennas if they are scaled down to microwave dimensions. However, it is not always possible to reduce all of the significant dimensions in the proper ratio. Appropriate compensation for these discrepancies may be made in the final full-scale model of the antenna.

Acknowledgment[5]

The writers are grateful to the Georgia Tech Engineering Experiment Station for the assistance given them in the construction of the measuring equipment.

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[1a] King, R. W. P., *Electromagnetic Engineering*, Vol. 1, p. 316-320, McGraw-Hill Book Co., Inc.; 1945.

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TUBE *Engineering News*

Design and Application Notes on the TV Image Dissector. Blowers Used for Cooling External Anode, Tube Header or Electrode Seal, or Glass Envelope of Radiation-Cooled Anode Type Tubes.

The Image Dissector[1]

THE IMAGE DISSECTOR pickup tube, used in telecine projectors,[2] and also for direct pickup where the average subject brightness is not less than 150-250 candles per square foot when used with a f/2.5 lens, has many interesting design and application features.

Internal parts of the tube are a photo-sensitive cathode, an anode for accelerating the electrons emitted therefrom, and a shielded target containing a small aperture and an electron-multiplier. Its external accessories are a focusing coil, a high-frequency horizontal scanning coil and a low-frequency vertical scanning coil.

The cathode is a spun silver cup with a flat bottom on whose inner surface a caesium-silver oxide film has been formed: it occupies one end of the glass cylinder. The other end is a plane glass surface. The anode is a conducting nickel coating on the inner surface of the cylinder. The target is placed close to the plane glass end. The entire cylinder fits into the focusing coil by which an axial magnetic field is established throughout the length of the cylinder. The coil and tube are placed within a supporting framework, consisting of the horizontal and vertical scanning coils.

The dissector is operated[3] by focusing an optical image from a lens through the plane glass end on to the photo-sensitive cathode at the other end.

Electrons are accelerated from the cathode toward the target by means of a positive potential of several hundred volts on the anode and, by means of the axial magnetic field from the focusing coil, are sharply focused as an electron image in the plane of the aperture in the target. The number of electrons per unit area in this electron image corresponds to the brightness of the corresponding areas in the optical image focused on the cathode.

Sensitivity

The cathode of a dissector tube has a sensitivity of 30 to 45 microamperes per lumen. Its caesiated surface has a spectral response which peaks at about 7,500 angstroms. If a tungsten lamp at normal brilliancy is used as the source of light, the combination of the two spectral distribution curves results in *best focus* being obtained at about 8,000 angstroms. With 10 lumens in the high lights (200-foot candles when the optical area is 2¼" x 3"), a dissector having a sensitivity of 35 microamperes per lumen provides a calculated current of 1.3×10^{-9} amperes through the aperture.

If we assume a constant secondary emission ratio for each multiplier surface, we can find the output current with the equation, $i = i_0 s^n$, where i_0 is the initial photocurrent, s is the secondary emission ratio, and n is the number of stages. With 100 volts per stage, s is found to be approximately 2.6. With 11 stages, 1.3×10^{-9} amperes is thus amplified to 50 microamperes. Across a 4,000-ohm resistor we have a .2-volt signal, when the resistance is calculated for a video cut-off frequency of 3.5 mc. In view of this relatively high voltage output it is often possible to use a single stage in the head amplifier of a television camera.

Resolution

Assuming that the optical image on the dissector-tube is 1½" x 1⅛", and that the ratio of the optical image to the electron image area is 1 : 2, a 525-line theoretical resolution with a 4 : 3 aspect ratio can be obtained from a scanning aperture .007" square. This aperture size divides the image into approximately 350,000 picture elements. A larger electron image permits the use of a larger aperture to obtain the same resolution, since the resolution is a function of the ratio of the aperture size to the size of the electron image. An aperture .012" x .012" has been found to be effective in giving a good

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[1] Farnsworth.

[2] In telecine operation it is customary to use a light source in the projector to provide about 200 foot candles on the cathode of the tube.

[3] *Typical operating characteristics*: Amount of light for good pictures, 20 lumens; standard defining aperture, .012" by .012"; dissector voltage, collector 0 v and cathode, 1500 v; dissector current, 0.2 ma; focusing coil current, 20 ma d-c; h-f deflecting-coil current, 250 ma; l-f deflecting-coil current, 16 ma. Multiplier voltage . . . 1st stage, 1100 v; 2nd stage, 1000 v; 3rd stage, 900 v; 4th stage, 800 v; 5th stage, 700 v; 6th stage, 600 v; 7th stage, 500 v; 8th stage, 400 v; 9th stage, 300 v; 10th stage, 200 v; and 11th stage, 100 v.

One of the first image dissector tubes made by Philo Farnsworth.

Current model of the Farnsworth image dissector.

signal-to-noise ratio for the 525-line resolution.

The tube's output is effectively the photoelectric current from the light-sensitive cathode. There are no secondary electrons near the cathode to rain back and reduce the contrast or otherwise introduce undesirable shading signals.

The photoelectric current is the only source of the output current, and therefore the d-c output is directly proportional to the picture background. This information may be utilized in several ways to provide the proper background level for transmitter modulation.[4]

Image dissectors are made in two standard sizes. One is a long tube with a cylinder length of 10½" and a diameter of 4½"; its target is placed off center. The other is a short tube with a length of 7⅜" for the same diameter, and requires special focusing and scanning coils; the target is in the center, near the plane glass end.

•

Blower Requirements For Forced-Air-Cooled Tubes

THE SELECTION OF A FAN OR BLOWER for a particular tube or application requires that three important factors be known; airflow required, static pressure at blower outlet, and amount of permissible noise.

Airflow Required

The airflow required depends upon the amount of anode dissipation and upon the maximum ambient temperature expected in a given application. This value of required airflow, usually measured in cubic feet per minute (*cfm*), and the corresponding value of anode temperature rise above the ambient value are given as part of the tube data. In no case should the sum of the ambient temperature and the anode temperature rise above ambient exceed the maximum rated value of anode temperature as given in the tube ratings. Because the cfm value is based on air of standard density (0.075 lbs/ft^3), a correction must be made for applications at altitudes greater than 5,000′ above sea level.

Static Pressure

The static pressure (P_s) at the blower outlet depends upon the pressure-versus-airflow characteristics of the system into which the blower must deliver the required volume of air. The static pressure for any system varies approximately as the square of the *cfm*^{2} and is determined by the following factors:

(*1*)—The static pressure rating of the tube cooler when the required airflow or cfm is passing through it. This rating is given in the tube data as a function of airflow or cfm. When the outlet of a blower discharges into free air, as is the case when a blower is directed at a tube header, bulb, or seal, the static pressure at the blower outlet is zero, provided no ducts, constrictions, or nozzles are used. This discharge rating in cfm of a blower at zero static pressure is sometimes called the *free delivery* rating of the blower.

(*2*)—The friction losses in connecting pipes and components such as elbows, interlock vanes, and air filters. Standard tables of duct-pressure loss may be used for estimating duct friction if the effective duct length is large.[1, 2, 3, 4]

(*3*)—The change in static pressure in a duct due to changes in cross-sectional area which increase or decrease the velocity of the air in the duct. Whenever there is any change in cross-sectional area between the blower outlet and the tube inlet, a correction for velocity changes must be added algebraically to the static pressure at the blower outlet. This correction, which is positive for a contraction in area and negative for an expansion in area, is given by the relation

$$P_s\ (\text{inches of water}) = \frac{V_2^2 - V_1^2}{(4000)^2} \qquad (1)$$

where, V_1 is the velocity of the air in feet per minute before the change in area and V_2 is the velocity of the air in feet per minute after the change. These velocities may be found from the expression

$$V\ (\text{feet per minute}) = \frac{cfm}{A} \qquad (2)$$

where, A is the cross-sectional area in square feet at the place of measurement. The factor *4000* of equation (*1*) is the velocity constance for air of standard density of 0.075 lb/ft^3. Corrections should be made for different values of air density from the data supplied in table *I*.

A change in cross-sectional area also causes friction losses. Such losses are small and can be ignored when the change in cross-sectional area is gradual and occurs over a duct length of more than six duct diameters. When, however, the change is abrupt, that is, when it occurs over a duct length of less than one diameter, a correction for friction losses must be made in addition to the correction made for velocity changes in the duct. For duct

[4]This feature eliminates the need for a separate photocell, and associated direct coupled amplifier, to pick up background information.

Altitude above Sea Level (ft)	Density of Air* (lbs/ft³)	Velocity Constant
0	0.0750	4000
1000	0.0722	4080
2000	0.0695	4165
3000	0.0668	4240
4000	0.0643	4320
5000	0.0619	4410
6000	0.0596	4500
7000	0.0573	4580
8000	0.0552	4670
9000	0.0532	4760
10000	0.0511	4850

*Temperature is constant at approximately 70°F.

Table I. Density of air and velocity constants versus altitudes

changes occurring over intermediate lengths, a correction for friction losses should be estimated. Corrections for friction losses, whether due to either a contraction or expansion in duct area, are always positive and are added to the system static pressure.

Permissible Noise

The third important factor which should be considered in the selection of a fan or blower is the amount of noise which can be tolerated. In general, a blower operating with high blade-tip velocity and developing a value of P_s in excess of two inches of water will usually produce a noticeable amount of noise in quiet surroundings.

A matter of lesser importance but which may require some design consideration is the effect of the temperature of the air leaving the tube cooler on some of the circuit components such as filament bypass capacitors. If some components are exposed to temperature exceeding their normal ratings, it will be necessary to reduce the temperature of the outgoing air by selecting a blower which will provide a greater airflow. The rise in temperature ($\triangle T$) of the outgoing air in the cooler may be determined from

$$\triangle T\,(\text{degrees C}) = \frac{T_1 + 273}{169} \times \frac{P_p + P_f}{cfm} \qquad (3)$$

where, T_1 is the temperature of the incoming air in degrees centigrade; P_p is the plate dissipation in watts; and, P_f is the filament power in watts. For incoming air at room temperature (25° C), this relation may be simplified to

$$\triangle T = 1.75 \times \frac{P_p + P_f}{cfm} \qquad (4)$$

The calculated value of $\triangle T$ will usually be higher than the measured value because some of the heat produced by the plate and by the filament will be carried away by conduction in the filament leads and cooler support. A further reason is that the heated outgoing air, because of its relatively high velocity, mixes immediately with the surrounding air.

Motor Overload

A further matter which is also usually of minor importance is the question of motor overload when the tube is removed from its socket. When this matter is important, a non-overloading type of blower such as one having backwardly inclined blades can be selected. Because higher blade-tip speeds are usually necessary with this type of blower, the noise output may be increased.

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[Blower requirement data based on copyrighted material supplied by RCA.]

Tube Type	Part Cooled	cfm	Cooling Recommended
6C24	Filament seals and grid connector	—	Deflect portion of main air stream used to cool anode.
7C24, 9C21, 9C22, 9C25, 9C27	Header and filament seals	10	Defleet portion of main air stream or use *A, B, C, D,* or *E* blowers.
9C21, 9C27	Bulb	250	*F.*
8D21	Bulb and electrode seal	40	*A, B, C,* or *E.*
833-A	Bulb and electrode seal	40	*A, B, C,* or *E.*
880	Bulb and electrode seal	20	*A, B, C,* or *E.*
889	Bulb and electrode seal	15	*A, B, C, D,* or *E.*
806, 826, 829-B, 834, 8012-A, 8025-A, 4-125A, 4D21	Bulh	—	Use ordinary small propeller fan or blower such as *A, B, C, D,* or *E.*

A—(ILG) . . . No. 6S, 70 cfm free delivery.
B—(Delco) . . . No. 5062369, 60 cfm free delivery.
C—(F. A. Smith) . . . No. 50747, 50 efm free delivery.
D—(F. A. Smith) . . . No. 50745, 15 efm free delivery.
E—(Amer. Blower) . . . No. 30H, 83 cfm free delivery.

Table II. Blowers for cooling headers, seals, and bulbs

Tube Type	Area (ft²)	Volume (cfm)	P_s (inches of water)	Blower Recommended
6C24	0.022	135	0	Use blower such as *G* or *H*, if a gradual transition is made from 3" outlet diameter of blower to 2" nozzle diameter required by 6C24.
7C24	0.12	275	1.75	*J, K, L,* or *M*
9C22	0.74	1800	2.4	*N, P, Q,* or *BB*
9C25	0.55	1000	2.25	*R, S,* or *CC*
827-R	0.12	100	0.45	*X* or *Y*
889R-A	0.31	500	0.95	*T* or *U*
891-R, 892-R	0.31	450	0.5	*V* or *W*
5588	0.012	10	0.4*	*A, B,* or *C*
5592	0.55	1100	2.65	*AA* or *BB*

These blower recommendations are based upon tube operation at maximum rated plate dissipation under class *C* telegraphy conditions at an ambient temperature of 45°C and at sea level. Unless otherwise specified, the static pressure at the tube inlet has been increased by 0.25" of water to allow for incidental pressure losses due to air filters, interlocks, etc. Direct-connected units are specified where possible.

*Without allowance for incidental pressure losses.

F—(Amer. Blower) . . . B Type P, 268 cfm at 2½" of water.

G—(Amer. Blower) . . . Type P Cat. A; ⅛-hp, 3450-rpm motor, direct connected.

H—(ILG) . . . Type P 7½P; ⅛-hp, 3400-rpm motor, direct connected.

J—(ILG) . . . Type B9; ¼-hp, 3450-rpm motor, direct connected.

K—(Amer. Blower) . . . Type P Cat. B; 1/3-hp, 3450-rpm motor, direct connected.

L—(Buffalo) . . . Type E 3E; 1/3-hp, 3450-rpm motor, direct connected.

M—(Clarage) . . . Type CI 6 (*C* wheel); ¼-hp, 1750-rpm motor, direct connected.

N—(Amer. Blower) . . . No. 105 utility set direct driven at 1725-rpm from suitable 1½-hp motor.

P—(Clarage) . . . Type HV ⅞ single width, single inlet belt driven at 1550 rpm by suitable 1½-hp motor.

Q—(ILG) . . . Type BW, No. 25 single width, single inlet belt driven at 1450-rpm by suitable 1½-hp motor.

R—(Clarage) . . . Type HV, No. ¾ single width, single inlet; 1-hp, 1750-rpm motor, direct connected.

S—(Amer. Blower) . . . B18; 1¼-hp, 1750-rpm motor, direct connected.

T—(Amer. Blower) . . . 1¼-H utility set; 1/3-hp, 1725-rpm motor, direct connected.

U—(Clarage) . . . DF ½; ¼-hp, 1750-rpm, direct connected.

V—(Buffalo) . . . Size D baby vent set, 1/6-hp, 1750-rpm motor, direct connected.

W—(ILG) . . . B-12; 1/6-hp, 1750-rpm motor, direct connected.

X—(ILG) . . . B-9; 1/20-hp, 1750-rpm motor, direct connected.

Y—(Buffalo) . . . Size B baby vent set; 1/20-hp, 1750-rpm motor, direct connected.

AA—(ILG) . . . BC-25, single width type BC, belt driven at 2250-rpm by suitable 1-hp motor.

BB—Buffalo . . . No. 2 single width type LL, belt driven at 2400 rpm by suitable 1-hp motor.

ILG Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill.; *Delco* Appliance Div., General Motors Corp., Rochester, New York; *F. A. Smith Mfg. Co., Inc.*, P. O. Box 509, Rochester 2, New York; *American Blower* Corp., P. O. Box 58, Roosevelt Park Annex, Detroit, Michigan; *Buffalo* Forge Company, Buffalo, New York; *Clarage* Fan Co., Kalamazoo, Michigan.

Table III. Blowers for cooling external-anode type tubes having integral air coolers

NOISE Measurements

by ROBERT L. MORGAN

Engineering Sales Manager
Norman B. Neely Enterprises

THE PROBLEM OF NOISE and its measurement is one that is rapidly gaining the attention of engineers in many fields, as the public is becoming increasingly more noise conscious and has come to appreciate the value of *noiseless* equipment and working conditions. However, this increase in acoustical activity, often on the part of engineers not trained in this field, has frequently resulted in considerable confusion and wasted effort. This is due, to a large extent, to a lack of a clear understanding of some of the terms and concepts used in acoustics and a failure to appreciate the many variables that enter into an apparently simple measurement.

Dr. E. J. Abbott, of the University of Michigan, once said, ". . . after an engineer has been told that 50 db at 4,000 cycles is louder than 60 db at 100 cycles because the ear is more sensitive to the higher frequency, and then he is told that 50 db at 100 cycles is louder than 60 db at 1,000 cycles because the loudness of low-pitched sounds increases more rapidly than high-pitched ones, and finally that 50 db at 100 cycles is louder than 60 db at 100 cycles, he is convinced that acousticians don't know what they are talking about, and it does not help him much to be told that the first comparison was made in sound pressure levels, the second in sensation levels, and the third was caused by a difference in reference levels."

Dr. Abbott has not exaggerated the difficulty, for to the newcomer, the relations involving reference levels, ear-weighting characteristics and loudness are often as perplexing as depicted above. However, they need not be so, and it is hoped that this discussion will help to clarify some of the confusion.

Sound measurements, when made with a standard sound-level meter, are determinations of sound-intensity levels and are expressed in decibels. This unit is approximately the smallest change in intensity level that the average ear can detect. Most engineers are familiar with this term as used in transmission engineering. It is defined here by the relationship db = $10 \log_{10} \left(\frac{E}{E_o} \right)$, where E is the energy flux density of the sound wave in question and E_o is 10^{-16} watts per sq. cm, the zero or reference level for sound-intensity measurements. This reference level approximately represents the threshold of hearing of an acute ear at 1,000 cycles. The intensity level of a sound is then defined as the number of decibels above 10^{-16} watts per sq. cm. Ten or more years ago one millibar (one-thousandth of a dyne per sq. cm.) of sound pressure was used as the standard reference level, which gave sound levels 13.8 db lower than those based on 10^{-16} watts per sq. cm.

Having established the terms in which sound measurements are to be expressed, it would be well to examine the range of sound levels that may be encountered. Figure 1 shows the range of intensity levels covered by some familiar sounds, with whispers and low conversation between 35 and 45 db, average home radio at about 70, and automobile horns, riveters and the like at 100 db or above.[1] As the intensity of a sound varies approximately inversely as the square of the listener's distance from the source, the sound levels listed here may vary over fairly wide limits, depending on their distance. It will be seen that audible sound may range from the threshold of audibility near zero db on up to about 120 db above this level, where the intensity becomes so great that sound begins to be felt as well as heard. This upper level is consequently called the threshold of feeling.

	Db	*Threshold of feeling*
	120	
Deafening		Thunder and artillery
		Nearby riveter
	110	Airplane taking off
		Average auto horn
	100	
Very loud		Home run at ball game
		Noisy factory
	90	Police whistle
		Niagara Falls
	80	
Loud		Heavy traffic
		Average radio
	70	Average conversation
		Average sound picture reproduction
	60	
Moderate		Vacuum cleaner in next room
	50	Quiet residential street
		Low conversation
		Quiet countryside
	40	
Faint		Average whisper
	30	Quiet residence
		Distant crickets
		Rustle of leaves
	20	
Very faint		Windless desert
	10	Soundproof rooms
		Threshold of audibility
	0	

Figure 1
Typical sound levels.

When making measurements in a *sound-proof* room, one should not be surprised to find the sound meter indicating levels that cannot be heard at all. This may be caused by two factors. First, it will be found that even in the most carefully constructed *sound-proof* rooms there may be appreciable sound energy present, generally of such a low frequency, that it is below audibility. This originates chiefly from traffic and other similar disturbances that vibrate the building and which, due to their low-frequency nature, are extremely difficult to insulate against. Although a room may have an insulation of 60 db or better at frequencies above 1,000 cycles, its insulation may often be of the order of 10 db for frequencies below 20 cycles where a great deal of the traffic rumble and vibration occurs. Secondly, when the acoustic energy actually is very low, the sound meter gain must be raised to high values to get a readable indication on the meter. Under these conditions the inherent electronic noise within the sound meter, consisting of thermal and vacuum-tube noise, may be amplified sufficiently to be readable. This electronic noise constitutes the lower limit near or below which actual sound level measurements cannot be made. A determination of the electronic noise level in the sound meter can readily be made by taking readings with a dummy microphone, consisting of a non-inductive resistor of the same value as the nominal microphone impedance.

Where it is necessary to measure

[1]These sound levels were measured using the appropriate ear-weighting characteristics, discussed in later portions of this paper.

Relation of Reference Levels, Ear Weighting and Loudness and Loudness Levels. Ranges of Sound Levels Often Encountered in Measuring Work. Use of Sound Meters. Microphone Positioning. Relation of Direct and Reverberant Sounds. Measurements in Rooms, Studio and Plants.

low sound levels, within a few db of the electronic noise level, recourse may be made to the formula: $C = 10 \log_{10} \left(\frac{R}{}\right)$ where C is the correction in decibels to be subtracted from the total noise reading, and R is the power ratio corresponding to the difference in decibels between the total noise and the background noise alone. This formula is useful not only against an electronic noise background, but also in the more frequently encountered case where a background of acoustic noise is present.

The range of sound levels usually encountered in measurement runs from about 30 to 120 db or a spread of 90 db. This constitutes a power ratio of one to one billion, that the microphone and sound meter must accommodate. They must have sufficient sensitivity to give readable indications on sound levels around 30 db or below and yet not overload at power levels a billion times as great. In the case of the microphone, this is a stiff specification, as the microphone has no input gain control to protect it from the higher levels.

Sound Meter

The sound meter itself is merely a high gain, quiet-operating amplifier provided with gain stabilizing features such as negative feedback. It is equipped with a gain control calibrated usually in 5 db steps and terminates in a rectifier working into a milliammeter calibrated in decibels. Generally a rectifying meter is employed with the rectifier contained in the meter case. Comprehensive standards[2] have been established, covering the frequency response of the amplifier and the dynamic characteristics of the indicating meter so that these approximate the corresponding characteristics of the human ear.

Engineers frequently complain that sound meters often give indications considerably at variance with what their ears tell them. This is a valid objection, but usually arises from a lack of an understanding of the characteristics of the human ear and the relation between intensity and loudness which is complicated and far from linear. For example, two sounds having the same intensity, and hence reading the same on a *flat*[3] sound meter, may not necessarily sound equally loud to the ear. Again, at certain intensity levels, noise A may sound louder than B, but if both are lowered 20 db in intensity their relative loudness may reverse with B sounding louder than A. Similarly, if two sounds of the same intensity, but different frequency, are shifted in frequency while keeping the intensity the same, their relative loudness may vary widely.

Figure 2 is fundamental to an understanding of this problem and will help to explain how these seemingly paradoxical effects can occur. This drawing gives, for the average ear, contours of equal loudness for pure tones throughout the audible range. The loudness level of a sound may be defined briefly as the intensity level of the equally-loud 1,000-cycle tone in the same position with respect to the listener. Thus, each contour is a locus of tones of equal loudness level and therefore shows the intensity level required at each frequency, in order that all frequencies will be heard at a particular loudness.

For example, let us consider the 10-db contour near the bottom. This is approximately the threshold of hearing for an average ear. At 1,000 cycles, an intensity level of 10 db would be required to cause the average ear to just perceive the tone. However, at a frequency of 30 cycles per second, an intensity level of about 68 db would be required to cause the tone to be perceived. In other words, near the threshold of audibility the sensitivity of the average ear falls off rapidly at low frequencies. However, the 100-db contour, which applies for very loud sounds, is practically flat (except above 1,000 cycles) so that an intensity level of 100 db will elicit about the same response from the ear at 30 cycles as at 1,000 cycles.

This explains why the bass response seems to drop out in a receiver as you

[2]*American Standard for Sound Level Meters*, bulletin Z24.3, American Standards Association. New York, N. Y.; 1944.

[3]Discussed under *ear-weighting characteristics*.

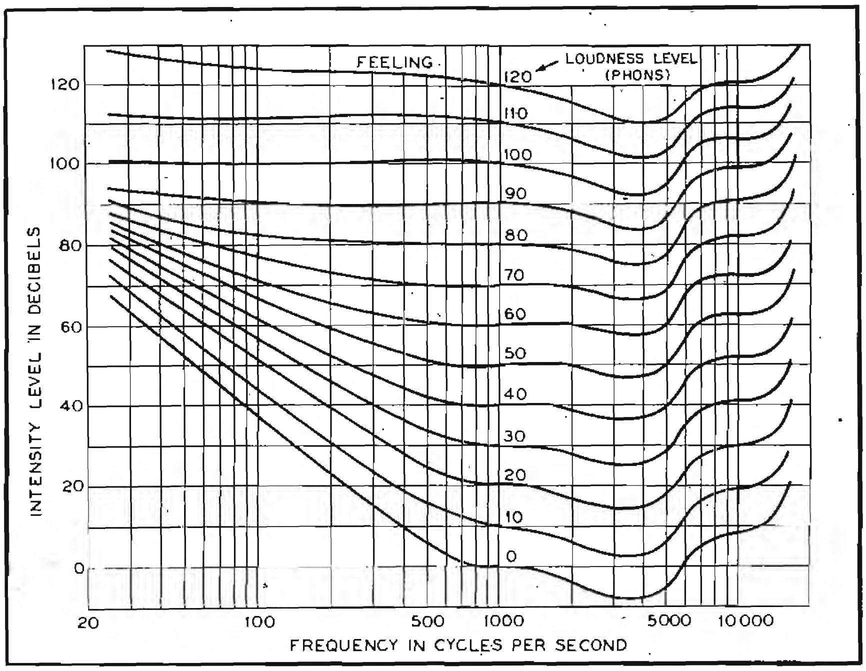
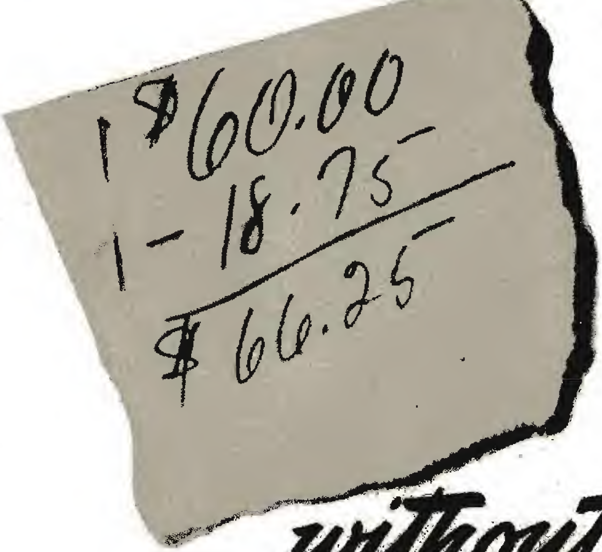


Figure 2
Loudness contours.

(Courtesy ASA)



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The State Director will gladly give you any assistance you wish.

"The National Debt and You,"

a 12-page pocket-size brochure, expresses the views of W. Randolph Burgess, Vice Chairman of the Board of the National City Bank of New York—and of Clarence Francis, Chairman of the Board, General Foods Corporation. Be sure to get your copy from the Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

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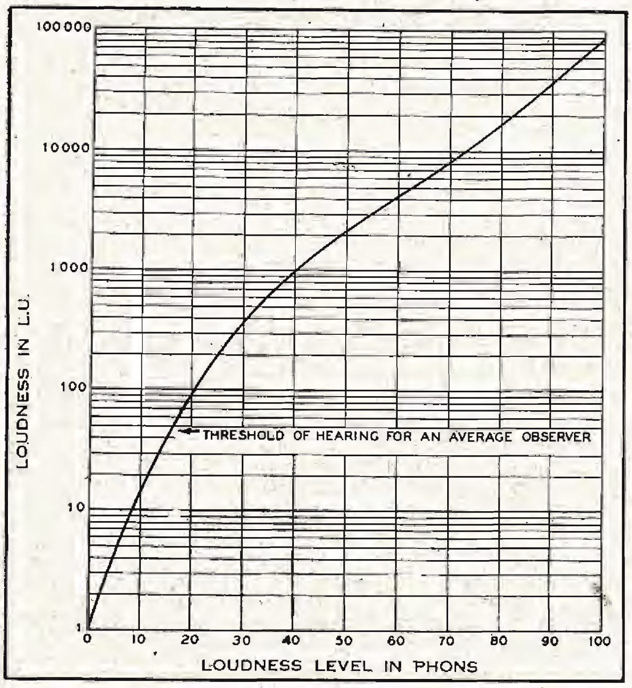


Figure 3
Relation between loudness and loudness level.

(Courtesy ASA)

turn the volume down low and why bass-compensated volume controls are needed. Another example of this effect can be noted when listening to a band marching down the street. As the band passes into the distance, the bass drum fades out first, followed in turn by the other low-pitched instruments until finally, to the ear, the band seems to be composed entirely of brasses and the higher pitched instruments.

Loudness level and intensity level are, by definition, equal at 1,000 cycles, but it will be noted from Figure 2 that they are also equal at a frequency between 5,000 and 6,000 cycles, depending on the loudness level. (The phon is the unit of loudness level. Thus 50 phons and a loudness level of 50 db express the same thing.)

Loudness level is not loudness as the layman understands the term. He is accustomed to speaking of one sound as twice or ten times as loud as another. But loudness level does not readily permit of such a comparison. For example, a loudness level of 60 phons does not sound twice as loud as a loudness level of 30 phons, but more nearly twelve times as loud.

To overcome this objection the relation between loudness and loudness level, shown in Figure 3, has been agreed upon. This drawing has an arbitrary logarithmic scale of loudness running from 1 to 100,000, corresponding to a linear scale of loudness levels from 0 to 100 db. By this relationship a loudness of 3,000 sounds three times as loud as one of 1,000. This curve makes it possible to relate loudness to loudness level and in turn, through Figure 2, to intensity level and thus achieve a quantitative relationship between what the ear hears and what the sound meter reads. On the more linear part of this curve, from 40 db up, which is the range most commonly encountered, a 10-db change in loudness level corresponds to changing the loudness by a factor of approximately two.

While Figure 3 is valid for any sound, it must be remembered that the loudness contours given in Figure 2 apply to pure tones only. The loudness level of complex sounds can be calculated if the frequency and amplitude of the components are known.[4] Otherwise, the loudness of the complex sound can be compared aurally to the loudness of a pure tone whose intensity level can be measured and converted to loudness level by Figure 2.

From the loudness contours, it will be seen that for a sound meter to have a response similar to that of the human ear, it would be necessary to provide it with a large number of interchangeable frequency characteristics, one for each intensity level that might be encountered. Obviously this is not practicable, but sound meters approximate this by providing the amplifier with two frequency-discriminating circuits, one to approximate the inverse of the 40 db loudness contour and the other approximating the inverse of the 70 db contour. A flat-frequency characteristic approximates the 100 db loudness contour and may be used for high sound levels. Thus at these three intensity levels the sound meter will respond approximately as the ear does. These characteristics, which are known as the ear-weighting characteristics of the sound meter are made available by operating a switch, which changes the size of an interstage coupling capacitor to droop the low frequency response.

When making noise measurements in which the annoyance factor of the sound is of interest and the sound meter should hear approximately as the ear does, it is necessary to use the ear-weighting characteristic which most nearly corresponds to the intensity level being measured. Absolute measurements without reference to the ear are made on *flat.*

Microphone Positions

An engineer making noise measurements for the first time may be surprised to find level differences of 5 db or more between microphone positions a few inches apart and equi-distant from the source. These differences are attributable to the interference pattern between direct and reflected sound which is never completely absent, even when measurements are made in the open air. At any given microphone position, these reflections will increase or decrease the sound level, depending on the relative phase of the reflected wave and the direct wave. As a result, some reflections will be in phase and will re-enforce the direct wave, while others will be 180° out and will cancel and all phase relations in between are possible. To minimize the variations resulting from interference, most acoustical test rooms are made highly sound absorbent but this precaution is not entirely adequate with ordinary commercially available sound-absorbing materials. It is, therefore, advisable to make a number of measurements in different microphone positions which can then be averaged to obtain a representative noise reading.

It should also be borne in mind that most pieces of equipment must be considered as a whole when determining their radiated noise. It is difficult, for example, to measure only the commutator noise of a motor, because all parts of the machine are fastened together in such a manner that sound is fairly readily transmitted from one part to another and the highest intensities may be found, not necessarily at their primary source, but at the particular part which is able to vibrate most freely. It is, therefore, advisable to make measurements spaced around a circle with the machine in question at the center.

[To Be Continued]

[4]H. Fletcher and W. A. Munson, *Loudness, Its Definition, Measurement and Calculation,* Journal of the Acoustical Society of America; October, 1933.

Bypass Capacitors

(Continued from page 19)

of value C_x. Since C' and C_x in series tune the coil, C is equal to the series combination of C' and C_x, or

$$C = \frac{C'C_x}{C'+C_x} \quad \text{or} \quad C_x = \frac{CC'}{C'-C} \qquad (5)$$

Experimental Check

Using the foregoing method, nine types**** of bypass capacitors (shown in Fig. 2) were checked at 30 and 100 mc. A tabulation of the results of the tests appear in Figure 3.

Only a few of the nine types could be considered effective for bypassing at 100 mc. Several of each type (more than four) were checked against each other to insure a truer sampling.

Operation of Q Meter

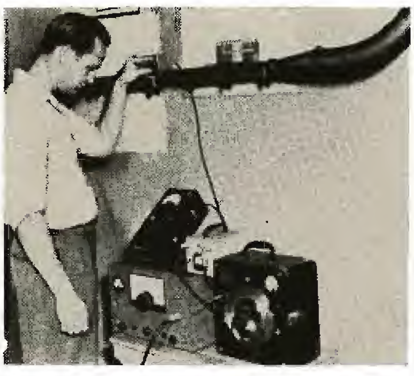
In the operation of the Q-meter, care must be used to eliminate errors from backlash. The change in capacity is quite small and is hard to measure at best, hence backlash will contribute an appreciable error.

As a final operational note, the Q of the circuit (coil) should be made high so the meter will read almost full-scale, thus allowing more accurate data.

****The types used happened to be on hand and were used simply to demonstrate the method.

•

360-KW F-M TEST BROADCAST



Owen Fiet, checking instruments used in making impedance measurements on a pylon antenna before and after a recent f-m test broadcast involving 360 kw of radiated power. *(Courtesy RCA)*

Facsimile Transmitter

(*Continued from page* 15)

ing by 18°, but only one of these positions is correct. The establishment of the correct angular relation is referred to as *phasing*.

A circuit is provided which acts on the scanner motor automatically until the correct relation is reached. A commutator with a pair of brushes is mounted on the drum shaft in the pulse generator and rotates at 360 rpm. It has a conducting segment which completes a circuit from positive plate supply through resistors for 6° of rotation.

The phasing commutator is a part of a driven sleeve which determines the angular position of the scanner drum when it is rotating. Its angular position is correct when the pulse-generator commutator-conducting interval occurs during the scanner-phasing-commutator non-conducting interval. If both commutators conduct simultaneously, a relay is operated by the plate supply from the pulse generator. A capacitor makes it possible for the relay to operate on the short pulse through the commutator. Operation of the relay opens the power supply to the scanner synchronous motor so that it momentarily drops below synchronous speed and the angular relation of the scanner drum to the pulse generator drum changes. This action is repeated until the correct angular position is reached.

Phasing of Recorder

It is also necessary to have a definite angular relation between the drums on the recorders and the drums in both the pulse generator and scanners. Both recorders phase automatically when a suitable signal is being recorded. This consists of a signal for recording black (maximum signal) for all but 15° of the drum rotation, during which the signal is zero.

If marking current corresponding to black is supplied to the recorder while the commutator circuit is made, a relay will receive a pulse of current each revolution of the helix drum. A capacitor across the relay winding makes it possible for the relay to operate on these pulses, which would otherwise be of too short duration. The operation of the relay slows down the synchronous motor. Since the signal for phasing is black except for a 15° interval, the relay will continue to operate with each revolution until the interval when the commutator circuit is made falls within this 15° interval. The recorder will then be correctly phased.

The Industry Offers

G-R 20-AMPERE VARIAC AUTOTRANSFORMER

A 115-volt model *Variac*, type V-20M, capable of handling 20 amperes, has been announced by General Radio Company, 275 Massachusetts Avenue, Cambridge 39, Mass.

Type V-20M is rated at 3.45 kva; a 230-volt model, type V-20HM, at 2.3 kva.

Output voltage is continuously adjustable from zero to 17% above input line voltage. Terminal box is designed for use with BX or conduit.

Overall dimensions are 7⅞" x 9⅝" x 5½".

* * *

G. E. SELENIUM RECTIFIERS

Two models of 1" square selenium rectifiers, 6RS5GH1 and 6RS5GH2, have been made available by the tube division of G. E.

Each rectifier is said to be able to withstand inverse peak voltages obtained when rectifying (half-wave) 110-125 volts, rms. Ratings are based on ambient temperatures of 50° to 60° C.

The forward voltage drop through the rectifier is approximately 5 volts at rated current output.

* * *

LENKURT ELECTRIC ELEVEN-CHANNEL CARRIER SYSTEM

A system, type 42, providing up to eleven duplex voice channels on a two-way radio circuit, has been developed by Lenkurt Electric Co., 1124 County Road, San Carlos, Calif.

System permits a 15-kc program channel with one to eight added carrier channels.

ALLIED CONTROL ALL-PURPOSE RELAYS

Two all-purpose relays, types PO and POY, have been announced by Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.

Type PO is supplied in 2-, 3- and 4-pole normally closed, normally open or double-throw contacts. Has standard silver contacts with carrying capacity of 15 amperes at 24 volts d-c or 110 volts a-c non-inductive. Coil rating up to 220 volts, 25 and 60 cycles at 10.5 volt amperes; 120 volts d-c at 2.5 watts. Dimensions of 3-pole are 2¼" (height) x 1⅞" (length) x 1⅝" (width). The 4-pole is 2¼" x 1⅞" x 2$\frac{3}{16}$".

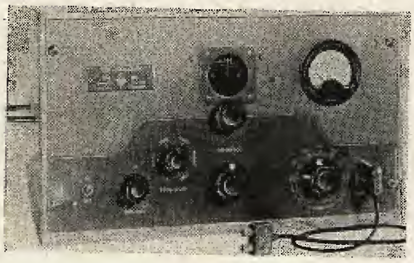
Type POY, intended for operation direct from plate of a tube or other limited power circuit, is a semi-sensitive, dual-coil relay for d-c only. Identical with type PO in contact arrangements, ratings, dimensions and mountings, except that it is not supplied with stop nuts. Coil rating up to 110 volts d-c at 1 watt.

* * *

HEWLETT-PACKARD RESISTANCE-TUNED OSCILLATOR

A resistance-tuned oscillator, model 650A, which covers a frequency range of 10 cycles to 10 mc, in decade ranges, has been announced by the Hewlett Packard Company, 395 Page Mill Road, Palo Alto, California. Voltage range is .00003 to 3 volts. Output impedance is 600 ohms; a 6-ohm impedance is also available through an output voltage divider, supplied with the instrument.

Other features of the oscillator include a 94" scale length, a 6 to 1 micro-controlled vernier tuning drive and a vacuum-tube voltmeter to monitor output in volts or db at the 600-ohm level.



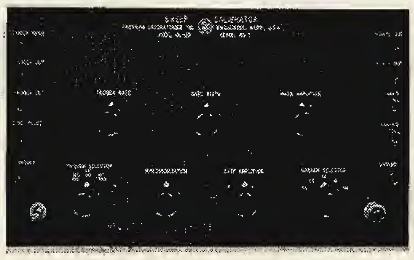
* * *

BROWNING SWEEP CALIBRATOR

A sweep calibrator, model GL-22, which is a pulsed timing marker oscillator designed for use with standard 'scopes and synchroscopes for the accurate measurement of time intervals on either triggered or recurrent sweeps, has been announced by Browning Laboratories, Inc., Winchester, Mass.

Variable amplitude markers of either polarity are provided with sufficient amplitude for use as intensity markers or directly on the cathode ray tube plates as deflection markers. Markers available are 0.1, 0.5, 1.0, 10, 100 microseconds. A positive or negative variable width gate pulse output is provided for test purposes. The duration of this pulse corresponds to the duration of the marker group.

Operation of the calibrator may be by use of external synchronizing triggers or from its own trigger generator with output triggers of both polarities available at front panel connections.



* * *

HARVEY SIGNAL GENERATOR

A v-h-f signal generator, 196TS, which is said to have a constant output and extremely low leakage, has been developed by Harvey Radio Laboratories, Inc., 439 Concord Avenue, Cambridge 38, Mass. Constant output is maintained by a feedback voltage control circuit.

Uses a piston-type attenuator; linear, directly calibrated in db. Range of attenuation, 0-114 db below .1 volt.

(*Continued on page 36*)

The Industry Offers

(*Continued from page 35*)

RMC HYPER-MAG SPEAKERS

Speakers featuring a *hyper-mag magnet* and a center dome with a parabolic projector which is said to provide broad high-frequency distribution have been announced by Radio-Music Corporation, Port Chester, New York.

The *hyper-mag magnet* design is said to concentrate the flux density in the working air gap with minimum leakage loss.

Three types are available, an 8" (12-15 watts) with a 100-10,000 cps range; 12" for 50 to 10,000 cps and 15 to 20 and 25-30 watts.

Bulletin HS-4 available upon request.

* * *

UTC TRANSFORMERS

A line of audio components, input transformers, modulation, power and filament transformers, CG series, has been announced by United Transformer Corporation, 150 Varick St., N. Y. 13, N. Y.

Audio components range from low level, hum-bucking, multiple-alloy shielded-input transformers to 600 watt *varimatch* modulation transformers. Power and filament components range up to those required for a 3,000-volt 1-ampere plate supply.

* * *

TRIPLETT MODULATION MONITOR

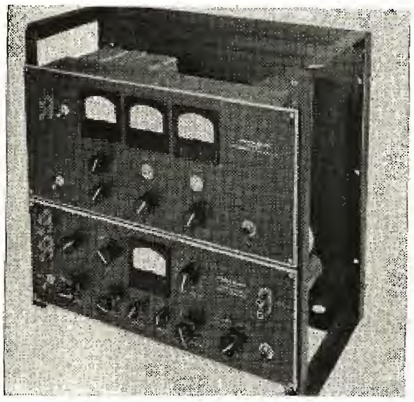
A modulation monitor, 3296, with tuning and a-f ranges of 1550 to 30,000 kc and 60 to 10,000 cps, has been announced by The Triplett Electrical Instrument Co., Bluffton, Ohio.

Four separate circuits for measuring a-m: Per cent modulation (average); peak flash per cent modulation; carrier shift; and audio output for headphone. The peak indicator may be preset for any per cent of modulation from 20-120. The per cent modulation meter provides a rapid up and slow down swing.

W. E. INTERMODULATION ANALYZER SYSTEM

A signal-generator (RA-1258) and intermodulation analyzer (RA-1257), have been announced by the Electrical Research Products Division of the Western Electric Company. In operation, a signal of two frequencies, the low between 40 and 150 cycles and the high either 2000 cycles or between 7000 and 12,000 cycles, are added by the signal generator with a minimum of amplitude modulation of one frequency by the other. The high frequency is attenuated to a desired ratio, which may be 1:1, 1:2, 1:4, or 1:10, and the two frequencies combined in a hybrid coil. Output levels range between +23 and —44 dbm at 600 ohms output impedance. The summed voltage is passed through the device under test.

The output from the equipment being tested is fed to the analyzer where the percentage of intermodulaton, or the percentage of amplitude modulation of the h-f signal by the l-f signal may be measured. A distortion phase meter is provided for determining, when measuring variable density recordings, whether compression is occurring on the positive or negative half of the low frequency signal.



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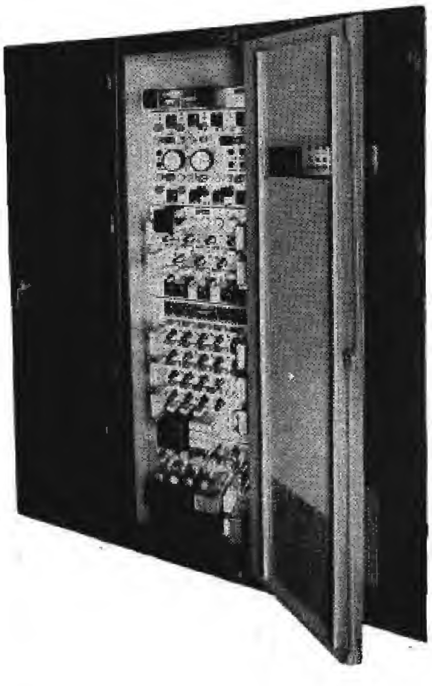
DU MONT SYNC SIGNAL GENERATOR

A synchronizing signal generator, model TA-107 A/B, has been announced by the television equipment division of Allen B. Du Mont Labs., Inc., 42 Harding Ave., Clifton, N. J.

Equipment conforms to RMA and FCC specs for standard output signals, horizontal and vertical driving signals, composite video blanking signal, and composite sync signal. Linearity test signals at 900 cycles provide 15 horizontal bars, while 157.5 kc signals provide 10 vertical bars mixed with blanking, by means of a switch, for use in checking scanning linearity of picture monitors and television receivers. These horizontal and vertical bars appear on two 3" cathode-ray tubes used in simultaneous monitoring (without



switching) of all frequencies in the sync generator.

Leading edges of equalizing pulses are also leading edges of horizontal and vertical sync pulses, thus insuring perfect interlacing. A crystal oscillator at 157.5 kc, or a highly stable self-excited oscillator, may be selected by a switch for use as master oscillator. Self-excited master oscillator is useful for synchronizing the generator, by means of lock-in circuit, to 60-cycle power line or to a remotely generated sync signal.

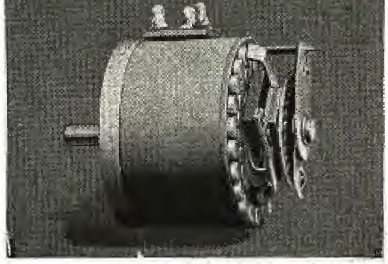
* * *

SHALLCROSS BRIDGED T ATTENUATORS

A series of bridged T attenuators of 2⅛" in diameter, has been announced by the Shallcross Manufacturing Company, Collingdale, Pa.

The series 420-OBO 20-step, are said to have an attenuation characteristic essentially flat from 30 to 15,000 cycles; attenuation in *off* position is said to be 100 db or better. Resistors are noninductively wound and sealed against moisture and shock.

The back-of-panel depth is 2" for all units, or 2$\frac{5}{16}$" when equipped with detent mechanism.



News Briefs

INDUSTRY ACTIVITIES

The IRE-RMA Spring Meeting on transmitters will be held at the Syracuse Hotel, Syracuse, N. Y., on April 26, 27 and 28.

The Spring Meeting committee consists of Dr. W.R.G. Baker, vice president of G. E. and engineering director of RMA, V. M. Graham, Sylvania Electric, and associate director of engineering of RMA, E. A. LaPort, RCA International Division, and M. R. Briggs, Westinghouse Electric Manufacturing Company.

L. C. F. Horle, chief engineer of RMA and L. G. Cumming, technical secretary of IRE will arrange the technical committee sessions. J. J. Farrell, G. E., will handle arrangements for the technical program.

The Los Angeles section of the IRE will hold its Pacific Coast convention at the Los Angeles Biltmore on Sept. 30 and Oct. 1 and 2, simultaneously with the 4th annual Pacific Electronic Exhibition. C. Frederick Wolcott, technical director for Gilfillan Bros. Inc., will svere as IRE liaison man for the exhibition.

Officers of the IRE Los Angeles section are: Walter Kenworth, consulting engineer, chairman; Bernard Walley, RCA-Victor field engineer, vice chairman; Ray Montford, Los Angeles Times chief television engineer, secretary-treasurer; and Lloyd Sigmon, KMPC chief engineer, coast convention chairman.

A. T. & T. has filed rates with the FCC for 50 to 15,000 cycles intercity channels.

Monthly rate asked for is $10 a mile. Rate for 5,000-cycle channel, type most commonly used by broadcasters at present, is $6 a mile.

C. P. Clare & Co. has moved its N. Y. City office to suite 310, 420 Lexington Avenue.

American Relay & Controls, Inc., 2555 West Diversey Avenue, has been purchased by David T. Siegel, president of Ohmite, Inc. Plant will be at 4900 West Flournoy St., Chicago 44, Ill.

Selenium Corporation of America, an affiliate of Vickers, Inc., Detroit, Michigan, and a unit of The Sperry Corporation, has been voluntarily dissolved, and succeeded by the Vickers Electric Division, Vickers Inc., 2160 East Imperial Highway, El Segundo, California.

The Parts Section of G. E. has been transferred from the Specialty Division to the Receiver Division.

Russell S. Fenton, who was sales manager of the section while it was incorporated in the Specialty Division, will continue in that capacity. J. K. Eaton will remain as supervisor of commercial service.

PERSONALS

Virgil M. Graham, director of technical relations for Sylvania Electric Products Inc., has been elected chairman of the Joint Electron Tube Engineering Council which is sponsored by the RMA and NEMA.

V. M. Graham

• • •

William Petzold and Frank Holdenecker are principals of a new organization, The Dilks Company, located at Seymour, Conn., manufacturing Dilks Vocal-Aire speaker units.

Anthony Marra and **Arthur J. Sanial,** have purchased the portable electric megaphone patents, rights to manufacture, and inventory, from the Guided Radio Corporation, N. Y., and have formed the Audio Equipment Company, Inc., at 80-20 45th Avenue, Elmhurst, N. Y., to produce these megaphones. Marra will serve as president and Sanial as chief engineer.

Marra is owner of Audio Engineering Corp., Brooklyn, N. Y. Sanial was formerly chief engineer and vice president of Guided Radio.

Ray Hutmacher of Ray Hutmacher & Associates, Chicago, has become Utah Radio representative in Illinois, Wisconsin, and St. Louis County, Missouri.

James F. Cosgrove has joined the Federal Telephone and Radio Corporation, Clifton, N. J., to act as district representative for broadcast equipment in the New York-New England area.

R. P. Lamons formerly eastern district representative for Andrew, is now with FTR as district representative for broadcast equipment covering Illinois, Indiana, Michigan, Ohio, Kentucky, Minnesota, Wisconsin, Missouri and Kansas. Headquarters are at 343 N. Michigan Blvd., Chicago.

Wm. E. Wilson, who has been sales manager of the Acme Electric Corp. of Cuba for the past three years, has been elected vice president in charge of sales.

E. E. Crump, formerly of Bell Telephone Labs. and L. L. Libby, formerly with Federal Telecommunications Labs. are now president and chief engineer, respectively, of Ohmega Labs., Inc., Pine Brook, N. J.

Corporation is an outgrowth of Kay Electric Company, Pine Brook, N. J., who will relinquish its special development work to Ohmega and concentrate on the manufacturing of electronic measurement instruments.

Donald E. Busse has been appointed sales engineer of Wilcox Electric Company, Inc. Busse was formerly with Trans World Airlines as supervisor of ground radio engineering.

D. E. Busse

* * *

William O. Spink has been named field engineer for the radio division of Sylvania Electric Products Inc. Spink will cover Michigan, Ohio and Indiana territories.

Robert A. Elliot is now manager of RCA broadcast audio sales. Prior to this assignment, Elliot supervised export sales of broadcast audio equipment for the RCA International Division.

Richard H. Rudolph has been appointed sales manager of precision and laboratory test equipmnt and crystals for the Specialty Division of G. E.

LITERATURE

Pickering & Company, Inc., 29 W. 57th Street, New York 19, have published a bulletin describing a diamond cartridge, model D-120M and equalizer amplifier, model 125H.

United Electronics Company, 42 Spring Street, Newark 2, N. J. have released a 12-page catalog, No. 1-GPW-7, describing graphite anode tubes and 30-kv vacuum capacitors.

The Seletron Division, Radio Receptor Company, Inc., 251 W. 19th St., New York 11, N. Y., have published a five-page bulletin describing 19 selenium rectifiers most frequently required by manufacturers, public utilities, labs., maintenance and test departments, railroad hobbyists, plating hobbyists, and amateurs.

The RCA Tube Department has prepared a 14-page technical booklet, RSB 1000, describing the *Special Red* tube line. Booklet is available from the Commercial Engineering Section, RCA Tube Department, Harrison, N. J.

First of the Special Reds, which are identified by red bases for glass types and red envelopes and bases for metal types, are the 5691, a high-mu triode; 5692, a medium-mu twin triode; and the 5693, a sharp cutoff pentode.

Tubes feature *girder* construction which is said to hold internal elements rigidly in adjustment and ultra-precise fitting of parts.

Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, California, have published a 4-page bulletin describing eleven instruments now being produced.

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for A-F DISTORTION and NOISE MEASUREMENTS

. . . in Sound on Film and Disc Recordings
. . . in Production Tests on Radio Transmitters & Receivers

FROM necessity, because of war production, the pre-war very popular Type 732-B Distortion & Noise Meter was dropped from the G-R line. It is now in production again to meet an insistent demand for a meter to supplement the new Type 1932-A which is designed primarily for broadcast and communication applications.

The Type 732-B is equipped with a 400-cycle high-pass L-C filter so that harmonic content measurements of a 400-cycle signal can be made rapidly. Because of the width of the pass band, unsteady signals, "wows" and other irregularities do not affect the accuracy of measurement.

The ease with which accurate measurements can be made over the distortion range of 0.25 to 30% and noise range of 30 to 70 db below 100% modulation, make it very valuable in these types of production testing:

ON RADIO TRANSMITTERS

- Signal-to-noise ratio
- Distortion vs { power, r-f levels, frequency, percentage modulation
- A-F response
- Noise vs carrier level
- Hum modulation
- Hum level

ON RADIO RECEIVERS

- Distortion & noise vs a-f output
- Whistle output at 2nd and 3rd harmonic of i.f.
- Two-signal cross-talk

The broad pass band characteristic of this meter is particulary useful when making distortion measurements on sound on film or on disc recordings where the fundamental frequency is not constant.

The Type 732-P1 Range Extension Filter is available as an auxiliary unit so that measurements at additional frequencies of 50, 100, 1000, 5000 and 7500 cycles can be made.

TYPE 732-B DISTORTION and NOISE METER $374.00
(For either 0.5 to 8 Mc or 3 to 60 Mc carrier range, specify which)

TYPE 732-P1 RANGE EXTENSION FILTER $209.00

WE HAVE A FEW IN STOCK. ORDER NOW FOR PROMPT SHIPMENT

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38